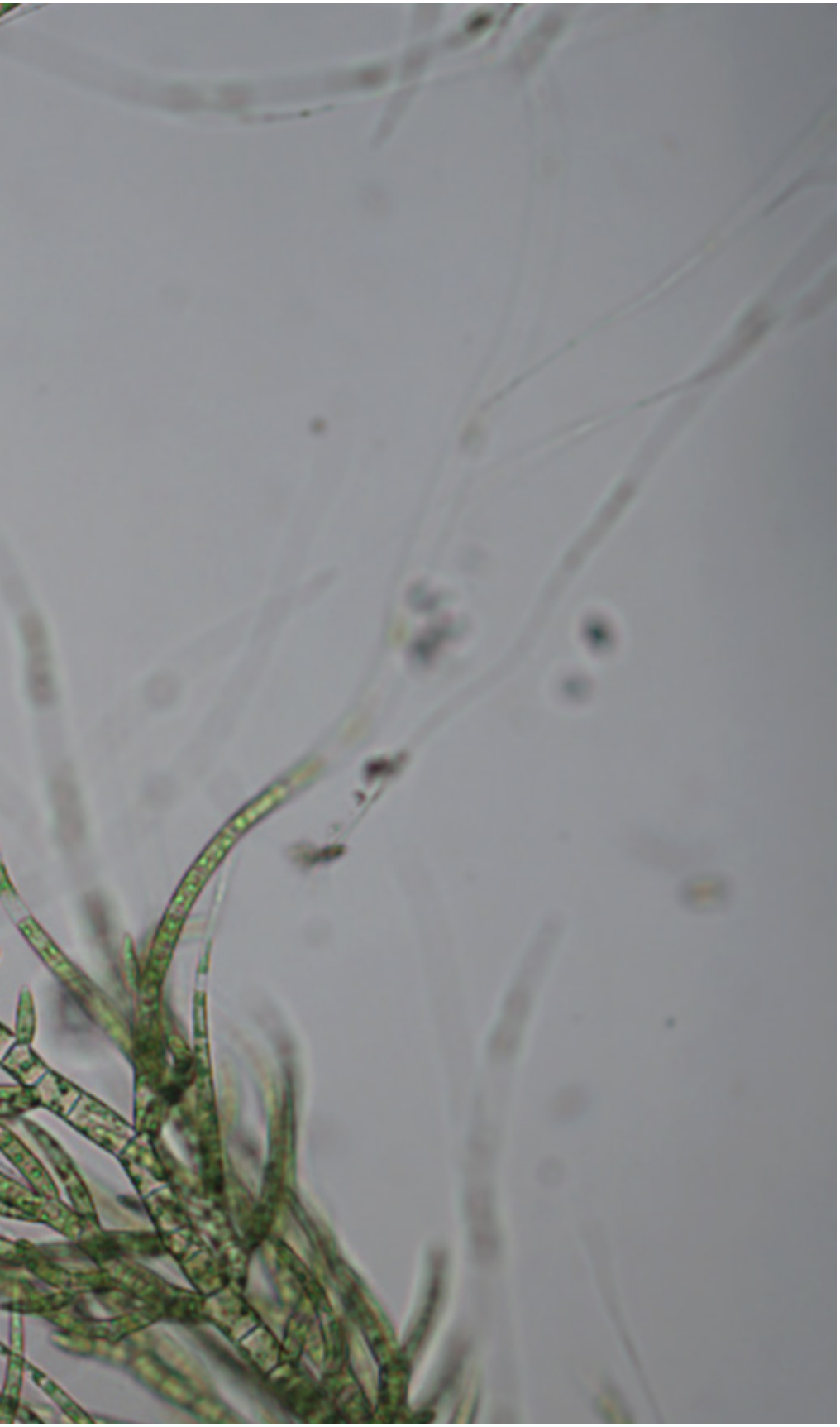
42

_A RACE AGAINST TIME

Drexel researchers are working to document the stunning biodiversity of Brazil's imperiled Xingu River—before it's too late.

BOTANY



_EVOLUTION, UNDER THE MICROSCOPE

The details of green algae are barely visible to the naked eye–most are much smaller than a grain of sand–but their beauty is revealed under the microscope. The research of Richard McCourt, a professor in Drexel's Department of Biodiversity, Earth and Environmental Science (BEES) and John Hall, a postdoctoral research associate at the Academy of Natural Sciences of Drexel University, is aimed at understanding the evolutionary relationships of these green algae and how they are related to land plants, of which they are close relatives. McCourt and Hall sequence DNA from these algae to reconstruct the evolutionary tree of green plants. The name of their project, GrAToL, is an acronym for Green Algal Tree of Life–a five-institution grant funded by the National Science Foundation. (See page 50 for more on their algal research.)

DRAPARNALDIA
Chaetophoralean green alga (Chlorophyta)

Draparnaldia is a green alga that grows in dense tufts attached to rocks in flowing streams and ponds.

COSMARIUM
Conjugating green alga (Charophyta)

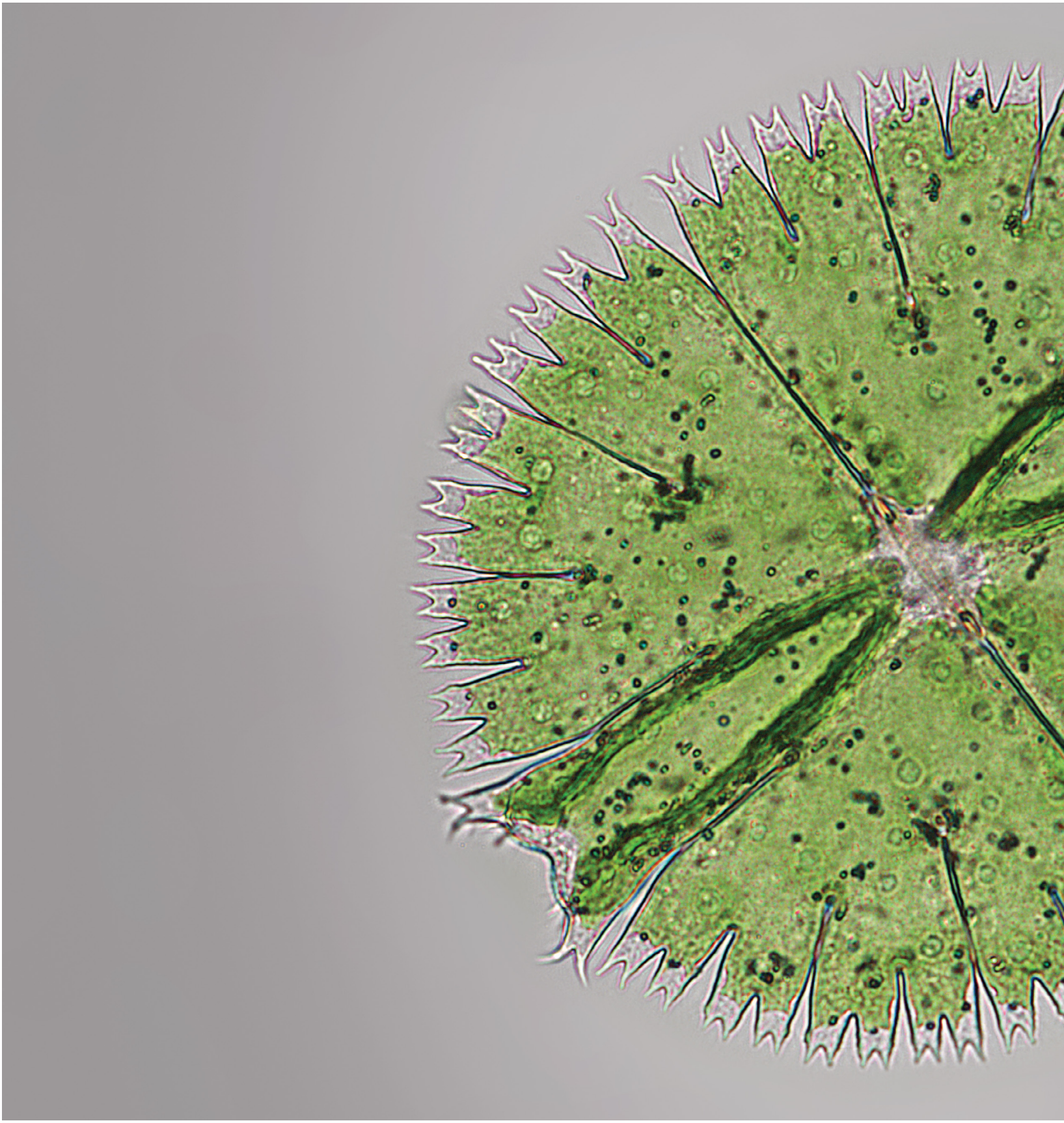
Cosmarium is a genus in a diverse group of green algae called desmids. Thousands of species thrive in freshwater habitats worldwide.

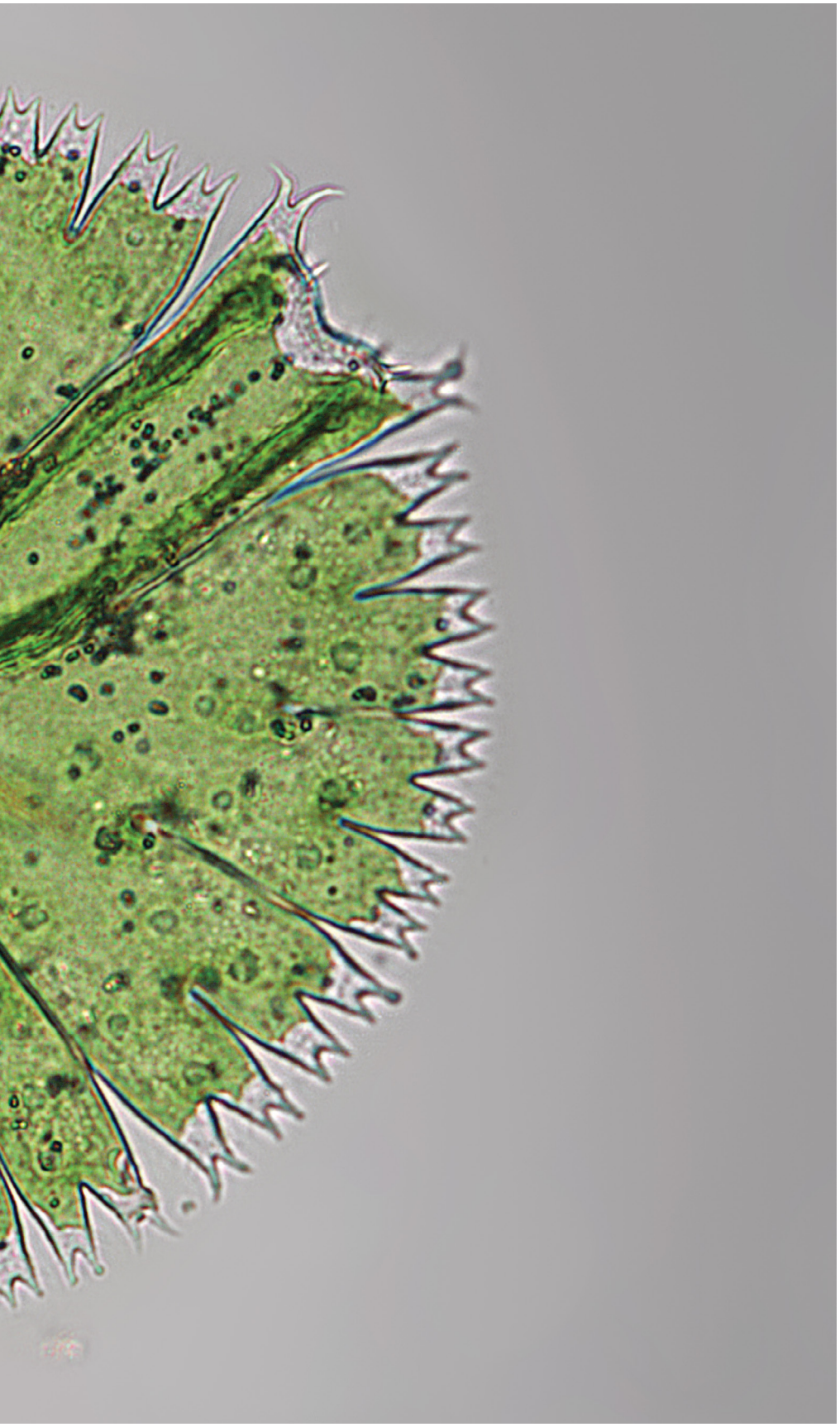
BOTANY

CHARA
Stonewort (Charophyta)

Chara is a branched green alga, growing as tall as a half meter. The dark, oblong structures are the fertilized eggs of the plant, which will be shed and germinate into new plants.

BOTANY





MICRASTERIAS
Conjugating green alga (Charophyta)

This desmid is a single cell with deeply dissected lobes. Species in the genus *Micrasterias* have been used in studies of cellular development—a process called morphogenesis.

_EXEL 2013

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2013

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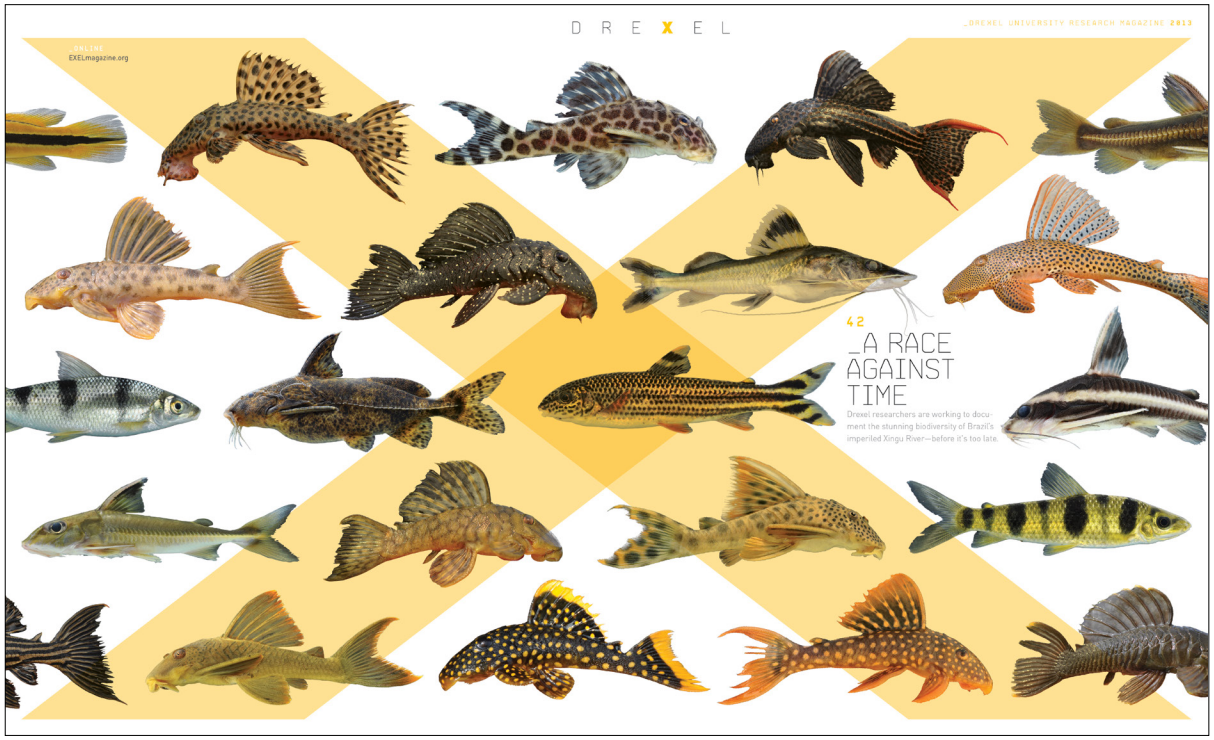
_RESEARCH, IN REAL TIME

Facing critical challenges with translational research



_ABOUT THE COVER
The fishes on the cover of *EXEL* represent a sampling of species native to Brazil's Xingu River—including *Peckoltia sabaji*, named after Academy of Natural Sciences of Drexel University Ichthyology Collection Manager Mark Sabaj Pérez.

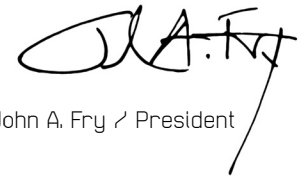
ONCE AGAIN, *EXEL* PAINTS A STUNNING PICTURE of a research enterprise more diverse and exciting than perhaps even the Drexel community fully realizes. But behind the arresting photos, the compelling personalities and the rich narratives, there runs a deeper current that speaks to the heart of Drexel research: critical investigations into questions where time is of the essence.

A Brazilian ecosystem threatened by the nation's remarkable progress…American bridges on the verge of collapse…an urban school system desperate for a new model…a pivot point for Venezuela as the Chávez era ends—all happening in real time, and all better understood thanks to Drexel researchers.

This focus on urgently important issues complements our excellence in translational research, which aims to turn scientific advances into life-enhancing technologies on the shortest timeframe possible. When governments, corporations or any other organizations want solutions quickly, they increasingly turn to Drexel.

This in no way diminishes the sheer exhilaration of expanding human knowledge through basic research—the pursuit of new frontiers whose impact may be not be clear for generations is one of the most noble aspects of science. But a research university should also be a partner in addressing the most critical challenges facing society. I am exceptionally proud of how Drexel accomplishes that.

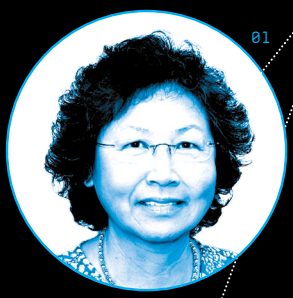
I encourage you to read this wonderful magazine, and think about the outstanding and innovative Drexel researchers racing the clock right now.



John A. Fry / President

_EXPLORE *EXEL* ONLINE

EXEL Magazine is also available online. Visit our site at EXELmagazine.org for online-only exclusive content, including interviews with Drexel researchers, videos about our exciting work, updates from our growing research enterprise and more.



AMONG_THE_HIGHLIGHTS_FROM_THIS_ISSUE

01 College of Nursing and Health Professions' Elizabeth Gonzalez looks into dealing with stress for Alzheimer's caregivers 02 Go behind the scenes of *The Drill Project*, a documentary produced by Drexel researchers about the dwindling Bioko drill monkey population 03 Department of Biodiversity, Earth and Environmental Science's Tracy Quirk evaluates ecosystem processes in New Jersey's salt marshes 04 The iSchool, College of Information Science and Technology's Sean Goggins goes in depth about the sociological impact of tweets in real time 05 Get the full look at the Department of Culture and Communication's Mimi Sheller's expedition to Haiti and the Dominican Republic 06 Jennifer Nasser in the Department of Nutrition Sciences finds that brain's pleasure response to tasting food can be measured through the eyes 07 LeBow College of Business' Yanliu Huang discovers that using targeted promotions via mobile devices is a more effective way to maximize unplanned spending than coupons

_ONLINE
To read the full-length articles that appear in this section, visit **EXELmagazine.org**

GAME DESIGN

_PLAYER ONE

Professor Frank Lee has pioneered ***gaming research*** *at Drexel from pixels on a computer screen to scaling Philadelphia's Cira Centre.*

_FRANK LEE
Lee is an associate professor in the Westphal College of Media Arts & Design and founding director of the Entrepreneurial Game Studio.

Frank Lee can see games anywhere. It first happened as an undergrad while he was driving on the Chesapeake Bay Bridge. The sun was setting, and he was mesmerized by how the light played off the building. He imagined a video game there. At the time, he didn't give it much thought, but then the same vision came again while gazing at the Cira Centre in Philadelphia—and this time he wouldn't let it go.

After four years of phone calls and emails, Lee planned to equip the 29-story building using 460 LED lights to create the spectacle of the world's largest video game.

"Watching it happen was almost like watching a child being born," he says. "I've been trying to do it for so long—and there it finally was!"

But there's one more incredible finish he has in mind. Lee's goal for the Game Design Program is the same goal he has for Philadelphia and its surrounding areas: to become a major player in the gaming world. After two years of teaching at Rensselaer Polytechnic Institute, he joined Drexel as an assistant professor focusing on cognitive research. But, as soon as he arrived, he could no longer hide his "secret" life—Lee wanted to incorporate gaming into the academic side.

"I offered, I believe, the first game class at Drexel. [I] got a grant for educational gaming, and I was on a search committee to bring in faculty. [Associate professor] Paul Diefenbach was brought in and that's been a huge part of this," Lee says.

In 2008, Lee and Diefenbach formed the Drexel game design program as co-founders and co-directors.

"You have to see it as the fusion of art and science," he says. "Eighty percent of games released commercially won't make their money back."

From presently working on a game for autistic children to help them learn facial recognition to even hoping to gain ground on one for ADHD, Lee clearly sees this as so much more than fun and games.

"It's different now," he says. "Before, you'd need so many people to create something and then you needed someone like Electronic Arts to say you could [create games]. Now with mobile games, you can create [them] just with a few friends and you don't need anyone to stop you from making a business happen. This is a great time for creative people—we just need to keep at it."

And for a man who scaled the Cira Centre—so to speak—persistence is one game he's not likely to quit.

ARCADE_STYLE
Video gamers gathered at the steps of the Philadelphia Museum of Art and controlled the Pong game using joysticks. Arcade games lined the space for participants to play during Pong downtime.

LEVEL_UP
Lee worked with Cira Centre owner Brandywine Realty Trust to transform the illuminated building into an interactive game.

CIRA_CENTRE_HEIGHT
29 stories *(437 feet)*

SURFACE_AREA_OF_NORTHFACE
8,536 sq. ft.

SIZE_OF_GAME
20 x 23 lights

NUMBER_OF_LEDS
460

APPROX_NUMBER_OF_PARTICIPANTS
200

BRIGHT_LIGHTS
Lee and his colleagues wrote the code that interfaces with the Cira Centre's Color Kinetics program to control its 1,514 LEDs affixed to the building's shadowbox spandrels.

BIOLOGY

_HIV AT THE MOLECULAR LEVEL

*Drexel researchers are developing a new method for **HIV Detection**, using "nanopores."*

Researchers at Drexel are less than five years away from developing a hand-held, point-of-care device that can rapidly detect HIV and certain types of cancer.

Traditional HIV tests are usually conducted in two stages. Patients often first learn of results through a rapid HIV test or an ELISA (enzyme-linked immunosorbent assay) test in which patients receive either a "negative" or a "preliminary positive" result in as little as 20 minutes. However, most rapid HIV tests must be confirmed with another test called a Western Blot, which often takes days or even weeks and is difficult to perform.

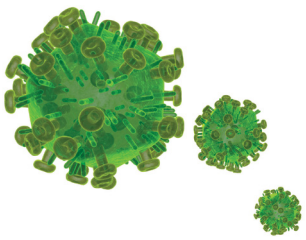
The research team believes their method can accurately confirm or deny the presence of HIV antigens in less than two hours, which would replace the need for both rapid HIV tests and the Western Blot.

"This is really transformative," says MinJun Kim, associate professor in Drexel's Mechanical Engineering and Mechanics Department and principal investigator of the project.

The benefit to the Drexel research team's nanopore detection method lies in the number of molecules needed to confirm the presence of HIV. Older methods detect HIV by obtaining a rather noisy signal coming from millions of molecules, whereas this new method detects single molecules, one at a time, in a consecutive manner. The result is higher resolution sensing while using a lower concentration of molecules, which in turn leads to more rapid detection than previous technologies.

Development of this detection technology was conducted by Kevin Freedman, PhD candidate in the Department of Chemical and Biological Engineering, and Rosemary Bastian, PhD candidate with the School of Biomedical Engineering, Science and Health Systems under the direction of Irwin Chaiken, a professor with the Department of Biochemistry and Molecular Biology, and Kim.

"With this technique, we have the ability to gather more information in a shorter amount of time," Freedman says. "It's extremely beneficial. We can work in much lower concentrations, which allows us to detect things earlier."



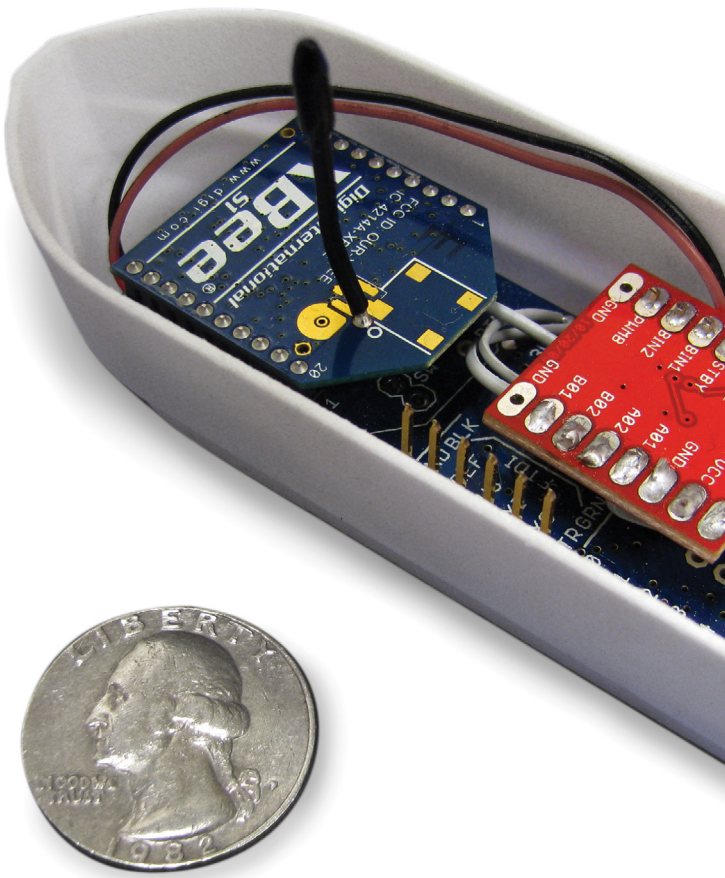
"With this technique, we have the ability to gather more information in a shorter amount of time. We can work in much lower concentrations, which allows us to detect things earlier."

-Kevin Freedman, PhD candidate in the Department of Chemical and Biological Engineering

SCALABLE AUTONOMOUS SYSTEMS LABRATORY

_ROBOTS ON THE HIGH SEAS

_M. ANI HSIEH
Hsieh is an assistant professor in the Mechanical Engineering and Mechanics Department and the director of Drexel's robotics program.



What if it were possible to predict where a message in a bottle was going to end up? According to one Drexel professor, removing the mysticism of that archetypal fate-guided, maritime missive could turn out to be a key to keeping the Navy's autonomous robots afloat.

In the Scalable Autonomous Systems Laboratory in Drexel's College of Engineering, M. Ani Hsieh is studying the currents in bodies of water, with the help of sea-faring autonomous robots that she's developing, in hopes of producing a high-seas road map of sorts.

What she's searching for are "flow boundaries"—the places where currents moving in different directions converge to form areas of powerful, directional flow. This information will be used to generate nautical models that will guide the Navy's unmanned, autonomous vessels. By traveling with the strong ocean flows, the Naval crafts can conserve energy, which will enable them to remain at sea for long periods of time.

Hsieh's robots will help to generate ocean current maps much like the ones produced recently by researchers from the California Institute of Technology using coastal radar at Monterey Bay in California.

To learn about mapping the movements of the world's largest bodies of water, Hsieh is starting by studying the movements of water in a plexiglass tank the size of a bathtub. With a grid of motorized turbines in the tank, Hsieh can control water currents and closely examine how they interact.

Playing the role of the message-in-a-bottle in this scaled-down experiment are tiny plastic pellets that float in the water. With the aid of the pellets, Hsieh can accurately discern the flow boundaries by observing the places where the pellets congregate and flow in a single stream.

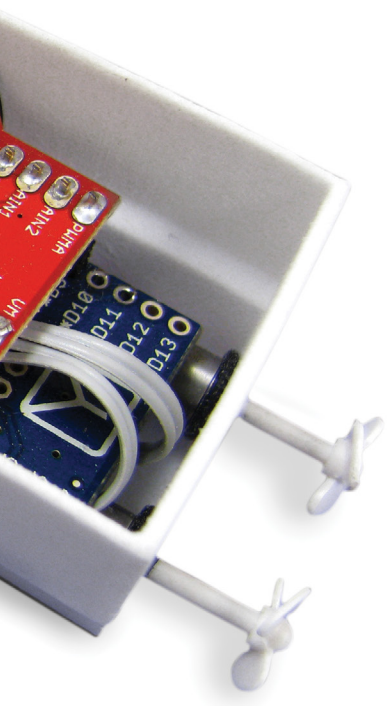
NAVAL_ROBOTS
Hsieh, whose work will continue as part of a National Science Foundation CAREER award for at least the next five years, is planning to develop her robots to the point where they can gather data in field trials in lakes and bays before passing the technology along to the Office of Naval Research.

"We're trying to map out the boundaries between flows, where the current tends to be strongest," Hsieh says. "For autonomous vehicles in the ocean, conserving energy is crucial—fighting currents is a big energy draw, so having a map that shows where the currents are strong could be quite useful."

As Hsieh scales up the

MEDICINE

SPORTS MEDICINE / PSYCHOLOGY



size of the bodies of water she's studying, she'll also increase the size of the robots she's using to study them. Currently, researchers in her lab are using a radio-controlled boat that could easily be mistaken for a bathtub toy.

But what the tiny vessel lacks in size, it makes up for in the lessons it can teach this group of engineers. While floating in Hsieh's flow-controlled tank, the boat can demonstrate the effects of the currents on autonomous robots, the challenges they will face in accurately collecting data and approximately how much longer they could last by traveling along the boundaries of the oceanic currents.

_SOAKING UP THE SUN

Solar panels, like those commonly perched atop house roofs or in sun-drenched fields, quietly harvesting the sun's radiant energy, are one of the standard-bearers of the green energy movement. But could they be better—more efficient, durable and affordable? That's what engineers from Drexel and the University of Pennsylvania are trying to find out, with the aid of a little nanotechnology and a lot of mathematical modeling.

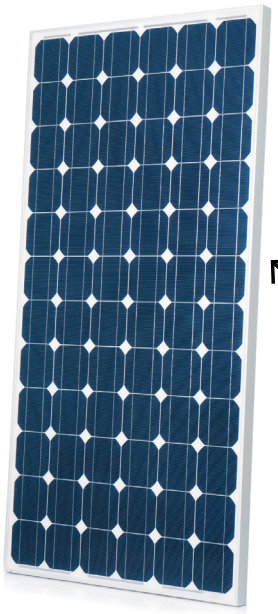
A three-year grant from the National Science Foundation has set the team on a track to explore ways to make new photoelectric cells more efficient, durable and affordable. The group is examining "dye-sensitized" solar panels, which capture radiation via photosensitive dye and convert it into electricity. Their goal: to streamline the electron transfer process inside the solar panels to make them more efficient at converting the radiation into electricity.

Dye-sensitized solar panels currently convert about 11 to 12 percent of the sunlight that hits them into electricity. The researchers are pushing to make these panels at least as efficient as their silicon counterparts, which currently convert about twice as much radiation as the dye-sensitized panels.

_MASOUD SOROUSH
Soroush is a professor of chemical and biological engineering in the College of Engineering.

Despite this relative inefficiency, dye-sensitized panels have many advantages over silicon cells. Among the advantages of dye-sensitized solar cells are low cost, ease of manufacturing and construction from stable and abundant resource materials.

"Our ultimate goal is to design and test a highly efficient dye-sensitized solar cell array through computational optimal design, synthesis and integration," says Masoud Soroush, the project's lead principal investigator from Drexel.



HIGHER_PERFORMANCE
Traditional silicon solar panels currently convert roughly twice as much radiation as dye-sensitized panels. Researchers are working to mitigate this difference and make the new panels more efficient.

_SKIN-DEEP CARDIAC CARE

Drexel scientists are among the first nationally to use a breakthrough treatment for patients at risk of ***cardiac arrest.***

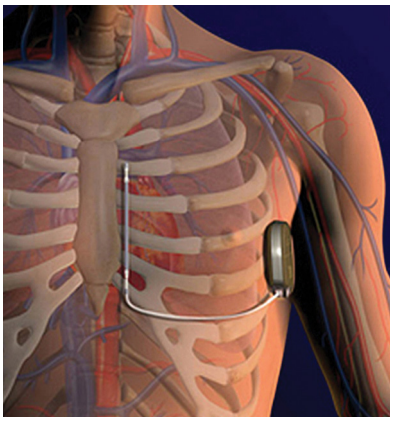
A new, less invasive heart defibrillator, recently approved by the FDA, is offering new hope to patients at risk of cardiac arrest. The device, which cardiologists are calling a breakthrough treatment, is known as an S-ICD, which stands for subcutaneous implantable cardioverter-defibrillator.

Physicians at the College of Medicine and Hahnemann University Hospital were among the first nationally to use the device in clinical trials. Drexel is one of the few clinical sites in the country participating in the post FDA-approval study, evaluating the long-term efficacy of the device. Doctors here have already implanted a dozen of the devices in patients, with several more procedures scheduled in the coming weeks.

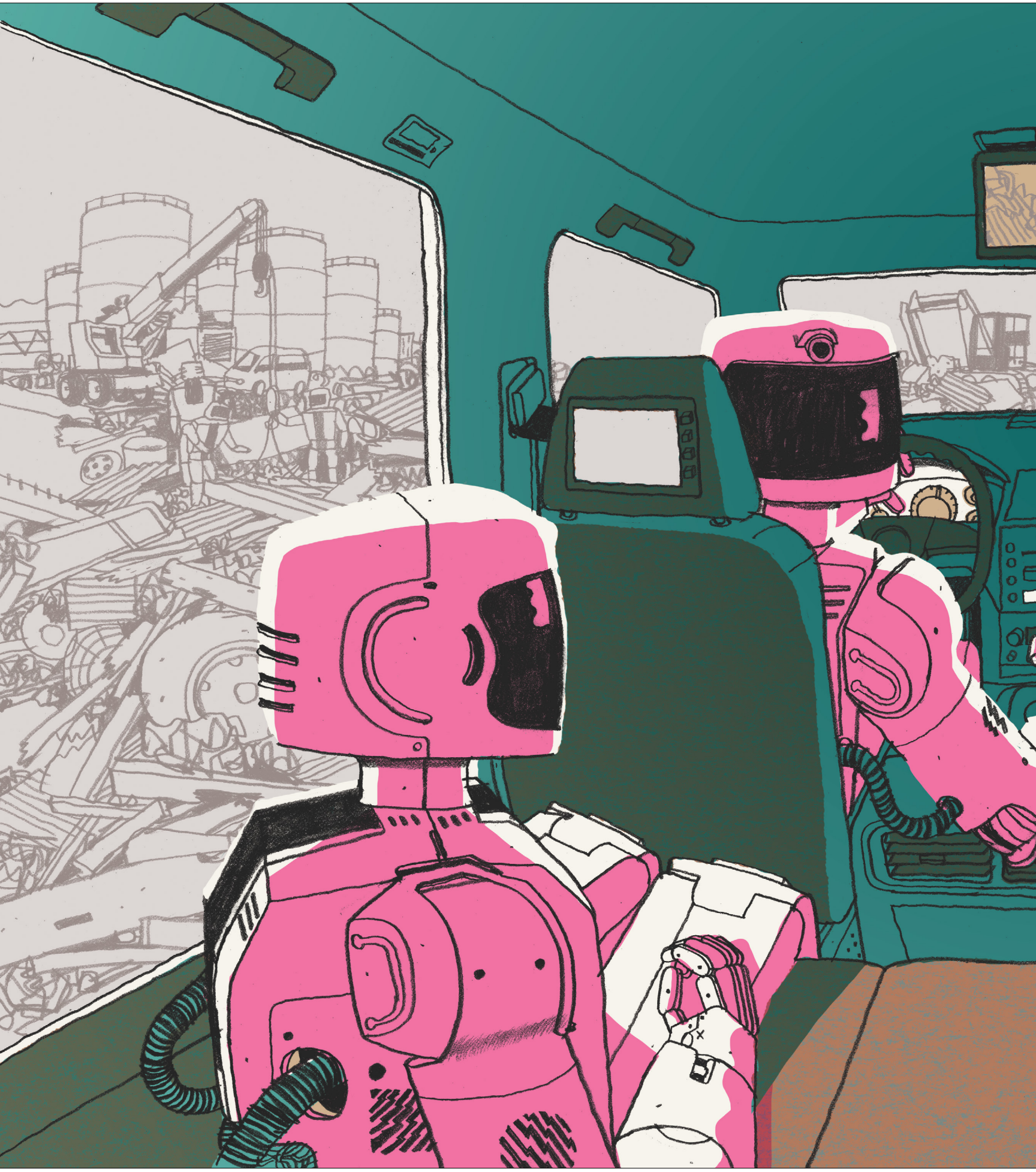
"This is the biggest breakthrough we've seen in cardiology since the invention of the VAD (ventricular assist device) in the 1980s," says Steven P. Kutalek, director of cardiac electrophysiology and associate chief of the Division of Cardiology at the College of Medicine.

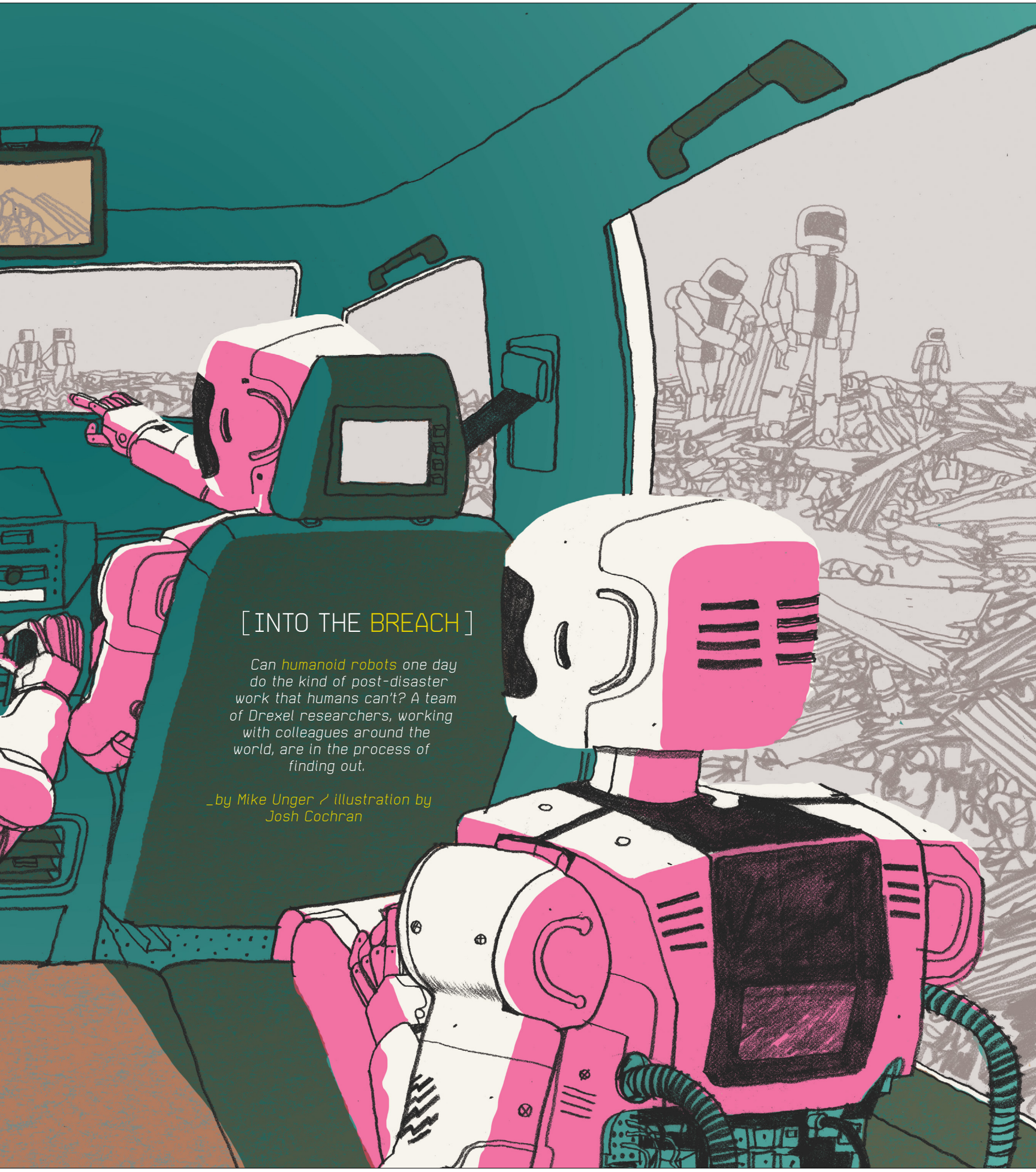
What makes the device unique is that it provides defibrillation therapy without actually touching the heart; instead it is placed under the skin. Traditional cardiac defibrillators run a wire—or lead—through veins into the heart. The wire is attached to an implanted defibrillator, which can send an electric shock to the heart to treat arrhythmia, an abnormally fast or chaotic heartbeat. But leads sometimes need to be extracted because of infections, or fracture due to the repetitive motion of the leads inside a beating heart.

"The implantable defibrillators we've been using for years are a wonderful option for preventing cardiac arrest in many patients," says Kutalek, who is a national expert in lead extraction. "Now this gives us another weapon in our arsenal to treat patients who can't tolerate standard defibrillators or those at increased risk of infection."



DEVICE_LIMITATIONS
Unlike standard defibrillators, the S-ICD currently can only be used for life-threatening rapid heartbeats like ventricular tachycardia or ventricular fibrillation. Standard defibrillators can also act as pacemakers.





[INTO THE BREACH]

Can humanoid robots one day do the kind of post-disaster work that humans can't? A team of Drexel researchers, working with colleagues around the world, are in the process of finding out.

_by Mike Unger / illustration by Josh Cochran

Fukushima, Japan, was among the most dangerous places on Earth in the hours, days and weeks following a massive earthquake and tsunami on March 11, 2011. The flooding of several reactors at the town's nuclear plant caused the biggest global nuclear meltdown in more than 25 years, and the world watched helplessly in horror as deadly radiation was released into the atmosphere.

Could robots have helped mitigate the disaster? Paul Oh, a professor in Drexel's College of Engineering, is leading a team of Drexel students and nine other universities in a challenge the U.S. Defense Advanced Research Projects Agency is sponsoring in hopes of answering that question.

"In the case of Fukushima, there was no absence of tools or vehicles, but the radiation levels were just so high you couldn't have people simply, quickly turn off a valve," Oh says. "If they were able to do that they could have prevented huge levels of catastrophe from happening."

Over the course of the next two years, teams from academia, industry and the private sector will attempt to design and deploy a robot capable of disaster response in radioactive or bio-contaminated areas. The robot must be able to drive vehicles, navigate human-centered environments, use tools and manipulate equipment.

It's a massive challenge, with a prize to match: the winning team will receive $2 million.

"This is a game changer for the university," Oh says. "Drexel is front row center on the world stage because of this DARPA challenge. We're up against some heavyweights. We're up against NASA, which has put a humanoid on the international space station. We're up against a $50 billion defense contractor named Raytheon and some other leading universities in the world. For Drexel to be part of this is phenomenal. I don't think Drexel's ever had this kind of opportunity."

The challenge formally began in October 2012, when a team led by Drexel that includes Columbia University, the University of Delaware, Georgia Institute of Technology, Indiana University, Korea Advanced Institute of Science and Technology, the Ohio State University, Purdue University, Swarthmore College and Worcester Polytechnic Institute, was selected to compete against six others.

The contestants have until December 2013 to design a robot that can mount, drive and dismount a vehicle; travel across rubble; remove debris; open a door; ladder climb; use a tool to break through a concrete wall; locate and shut off a leaky valve; and remove and replace a pump. All these tasks are necessary in disaster-mitigation situations like the one in Fukushima.

"You have robots that are in the operating room right now performing medical surgeries," Oh says. "You have drones flying around, you have robots vacuuming up rooms. There's a wide spectrum of tasks that are being performed by robots now, but this particular robot challenge is unprecedented. When it's all said and done, I think before the year 2020 you're going to see robots performing such [tasks] more commonplace."

But the teams in the DARPA challenge don't have seven years. The months are dwindling until the number of competitors is cut to two in December 2013. The semifinalists will have another year before they go head-to-head.

[THE COMPETITION]

NASA Johnson Space Center

NASA Jet Propulsion Lab

SCHAFT, Inc.
[University of Tokyo's Jouhou System Kougaku Lab]

Carnegie Mellon University

Virginia Polytechnic Institute and State University

Raytheon

The Drexel team, however, thinks it has a big advantage on its competitors. It already has the robots. The team is working with seven humanoid robots, named Hubo, developed by KAIST.

"Drexel's partnership with KAIST plays a pivotal role in the team's strategy," Oh says. "KAIST is a world leader in the electro-mechanical design and fabrication of the Hubo humanoid. Drexel and its American partners are world leaders in information technologies and artificial intelligence. The result is a team that collectively has over 200 person-years in hardware and software design of humanoids to apply to the challenge."

Perhaps no American knows the inner workings on Hubo better than Daniel Lofaro, a PhD candidate who's leading the team. He's been working with the 130-centimeter Hubos since 2007.

"It has two arms, two legs and a head," he says. "It has 40 degrees of freedom—that is 40 places that it can move. Six in each leg, pitch and roll on the hip, pitch in the knee, pitch and roll in each of the ankles, pitch and roll in the shoulders, pitch in the elbow, pitch and roll in the wrist. And then 10 fingers."

Hubo has sensors and an inertial measurement unit similar to our internal ears, which can tell how it's balancing. It also has sensors in its wrists and ankles that can tell the force that's pressing against the ground.

If Hubo sounds like it's a fully functional robot ready to roll out, think again, Lofaro says.

"This robot has not been particularly reliable in the past," he says. "These robots don't run on wheels, they are actuated. You tell the joints to go to a position and it will go there. When you tell it to go to a certain location it goes there and it stays there. Which is the down side in some respects and the upside in other respects."

The robots are controlled entirely by humans.

"Right now the robots are not autonomous," Lofaro says. "All the control is done on board. It has two computers on board right now, and you connect wirelessly and you give commands. To complete these events we need to make it autonomous because it's very clear that DARPA will artificially inject latency into the wireless communication, as well as no communication at all, so we can't rely on the signal. Just like a regular disaster situation. The robot has to be semi-smart."

Thus, the challenge for the Drexel team is as much a software one as it is a hardware one.

"We're working on our system that I'm creating with my partners at Georgia Tech that is a totally open-sourced platform that allows you to make a separate process that controls the robot just by setting joint angles," Lofaro says. "The beauty of this system is that if someone else's control fails, it won't affect yours. It's specifically designed so that multiple contributors can contribute and have their stuff fail and other people's stuff will still work.

"Because we have [multiple] universities working with us, that's really needed. This is a robot challenge, but it's also a human challenge. We have to deal with a lot of people who like to do things in different ways."

Oh and Lofaro seem supremely confident that their team can modify Hubo to meet the DARPA challenges.

"This is a robot challenge, but it's also a human challenge. We have to deal with a lot of people who like to do things in different ways."

-Daniel Lofaro, Drexel PhD candidate

"Technically, all of the events are very doable," Lofaro says. "Right now everyone's doing simulations on the real robot and they're finding out what they need to actually complete it. The robot's too short right now to actually drive a car. It can't reach the pedals, so we know we have to add length to the legs. But how much? We know we need longer arms, arms that are stronger, hands that are stronger. This is going to come out of our simulations, our real-world experimenting."

Software that interfaces properly with the hardware is a nagging problem, Lofaro says. His goal is to make that relationship as bulletproof as possible.

"A lot of people we work with are computer science guys and they're used to simulations where it just works. You tell it to do something and it does it. I want to be able to push the robot down, shake it, break its arms, and for it to get back up and say, 'My arm is broken but guess what, I'm still mostly functional.'"

Oh frames the challenge this way:

"A lot of robots don't really have the intelligence and perception and cognition level beyond even a 2-year-old child. For this challenge, where you're asking them to drive a vehicle, climb ladders, turn valves, open doors, you can't even imagine a 2-year-old doing that. So how do you create the software intelligence so that you can make them act more like a 10-year-old child?

"How do we give robots that sort of intelligence? We have to be able to teach the robot. The robot right now needs a lot of instruction. They need to know exactly what kind of ladder they're going to climb. How steep is it? What should they do when they get to the top of the ladder? How do they swing their legs over? You can just imagine an infant who's never climbed a ladder before—so what's involved in telling them what they can and cannot do.

"There's a lot of instruction that's required, and that's exactly what our team is focusing on."

In announcing the challenge, DARPA's Tactical Technology Office says, "The Department of Defense's strategic plan calls for the Joint Force to conduct humanitarian, disaster relief and related operations. The plan identifies requirements to extend aid to victims of natural or man-made disasters and conduct evacuation operations. Some disasters, however, due to grave risks to the health and well being of rescue and aid workers, prove too great in scale or scope for timely and effective human response. The DARPA Robotics Challenge will attempt to address this capability gap by promoting innovation in robotic technology for disaster-response operations."

Drexel is in a heady neighborhood, working on one of the world's most complex problems, competing against some of its leading technology institutions.

"We're kind of like the equivalent of Rocky here," Oh says. "We have no silver spoon. We don't have a $50 billion war chest that a defense contractor has, we don't have legions of engineers like NASA does. We've just got very hard working, very practically minded students and faculty.

"By winning this DARPA robotics challenge, we prove to the world that Drexel's brand of education works. That co-op and use-inspired research should not just be a national model, it should be a world model."

_CROSSING STATES

The Tacony–Palmyra Bridge is a combination steel arch, double-leaf bascule bridge across the Delaware River, linking from Pennsylvania to New Jersey.

_by Danica DeLizza / photograph by Mike Morris

_LOOKING BEYOND 'LOOKS'

THE HEALTH OF A BRIDGE IS NOT ALWAYS EASILY JUDGED BY ITS APPEARANCE. WITH THE HELP OF CUTTING-EDGE TECHNOLOGY AND THE TACONY-PALMYRA BRIDGE—EQUIPPED WITH ONE OF THE MOST ADVANCED STRUCTURAL HEALTH MONITORING SYSTEMS IN THE WORLD—DREXEL RESEARCHERS ARE WORKING TO BETTER UNDERSTAND BRIDGE BEHAVIORS.

In August of 2007, the I-35 West bridge in Minneapolis collapsed during rush hour traffic. The eight-lane bridge fell into the Mississippi River below, killing 13 people and injuring more than 140. This spectacular failure attracted much attention and numerous calls for increased infrastructure funding, but little tangible action was taken. Given the current political climate, increases in funding are untenable, and bridge owners will have to learn to deal with significant budget shortfalls for the foreseeable future. In the absence of resources, bridge owners need effective means of prioritizing investments to ensure the most pressing issues are addressed first.

Franklin Moon, a Drexel professor of civil engineering, studies bridges using sensors and computer simulation to help distinguish true safety issues from superficial ones. And when it comes to bridges, he says, looks can be deceiving.

1 in 9

of the nation's bridges are rated as structurally deficient

"A bridge can be rusty, with pot holes and broken concrete," he says. "But it can still be safe because it was built 10 times stronger than it had to be; or, a bridge can look great but be really unsafe because of a subtle design error."

Right now, bridge inspectors gauge a bridge's safety based on a visual, qualitative inspection; Moon analogizes this to a doctor's appointment in which a doctor's only means of evaluating a patient is to look at the patient. Bridge sensors are to a bridge what EKGs and MRIs are to people—they measure key performances that can't be seen physically.

Bridge sensor technology captures the way a bridge responds to changes. Using sensors, engineers are able to have a quantitative measurement of a bridge's health instead of relying on simply qualitative observations.

One of the current projects that Moon and his colleague, Emin Aktan, are working on is the design and implementation of a state-of-the-art structural health monitoring system on a Philadelphia-area bridge maintained by the Burlington County Bridge Commission—the Tacony-Palmyra that stretches across the Delaware River, connecting Palmyra, N.J., to the Tacony neighborhood in Philadelphia. The bridge has a number of sensors that capture its many behaviors, such as how it accommodates the expansion and contraction of steel and concrete caused by changes in temperature. When the sun rises in the morning, it heats certain elements of the bridge while other parts stay cool in the shade. This means the bridge is constantly fighting itself—a process Moon refers to as the "daily calisthenics."

Fortunately, the bridge sensors keep Moon and the BCBC in tune with the bridge's "health." They know the bridge's normal "exercise" pattern and can monitor to ensure it continues as expected. "If something were to change—if systems that are supposed to move stop moving—we'd know to take a closer look," Moon says.

The sensors, placed at different points throughout the bridge, measure acceleration, temperature, rotation and tilt, among other things. The measurements are accessible in real-time through a Web-based visualization portal that tracks the bridge's behavior. In addition, a detailed, calibrated com-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puter simulation model of the bridge has been developed and is available to examine a series of "what if" scenarios that can help engineers interpret measured data-—a feature that was enormously helpful during Hurricane Sandy.

Throughout the hurricane, engineers were interested in tracking mean wind speeds and gusts, as well as the bridge's response to these, so they'd be able to determine the safety of the bridge as the storm progressed. As the wind gusts increased in magnitude, the BCBC used the data to know when to shut down the bridge to pedestrians, motorcycles and ultimately all traffic to avoid the possibility of traffic accidents caused by high winds. Although the bridge was closed to traffic during the height of the storm, it was never in any danger itself. In fact, engineers found that the bridge's stress level was just a fraction of that caused by changes in temperature during a normal sunrise.

In addition to aiding the decision-making process, the real-time information provided by the health monitoring system has become increasingly useful in the classroom. "Students can select any sensor and view its response as cars and trucks cross it, so they can estimate from that reading how heavy the truck is and whether or not it's overloaded … It's not just a textbook; it provides a much more tangible picture of a 'day in the life' of a bridge."

While sensors can provide data that could conceivably save millions of dollars and lives, currently they are relegated to signature bridges like the George Washington Bridge in New York City. Moon explains, "With multi-billion dollar bridges—you can easily justify the type of investment that is required." The cost associated with bridge sensors is simply unrealistic for the nearly 600,000 run-of-the-mill bridges throughout the U.S.

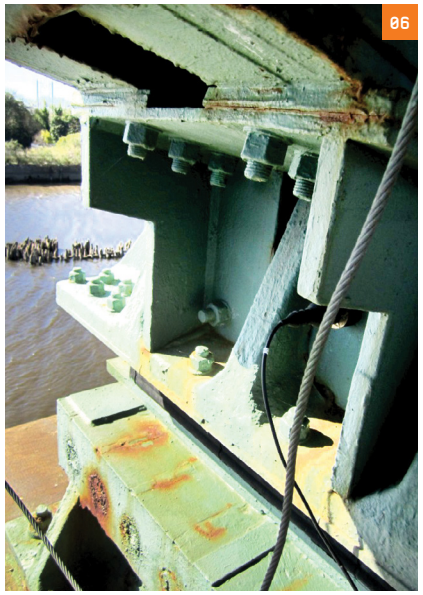
Fortunately, Drexel researchers have developed an instrument capable of acquiring quantitative data across large populations of run-of-the-mill (or short-span) bridges. If sensors are a bridge's intensive care unit, this instrument can be likened to a stethoscope. The prototype, developed at Drexel, is a self-contained vehicle with an impact device surrounded by sensor arms. The device raises and drops a large mass onto the bridge's surface to generate a 30,000-pound impact, and the sensor arms measure the resulting vibrations. Once the results are processed, a wealth of information about the bridge is learned.

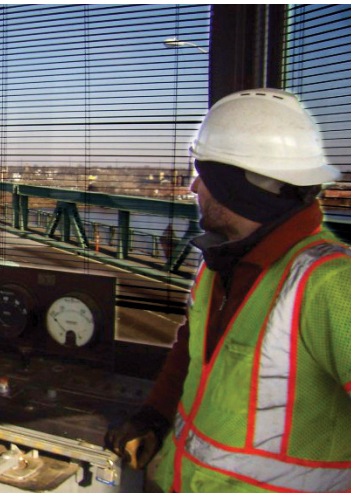
To examine the accuracy of the prototype, researchers performed a well-established (but costly and time consuming) test that involves closing the bridge and measuring its behavior under a number of heavy trucks. When compared to the Drexel prototype, the results are just about the same, demonstrating that the prototype's rapid means of capturing critical behaviors is sound.

Standard bridge inspections cost anywhere from $5,000 to $10,000 for short-span bridges (depending on size and access constraints), but provide only a qualitative assessment of a bridge's visual appearance. This new approach may be implemented for a similar cost, but it is capable of providing accurate quantitative data related to the safety of the structure. As our country ages, so does our infrastructure. It is becoming more necessary to invest time and money into roads and bridges—not only their development, but their maintenance as well. Fortunately, Drexel researchers are looking ahead and producing technologies that will help preserve the safety and integrity of our bridges.

_ TESTING THE TACONY-PALMYRA

01 Pennoni Associates employees inspect the underside of the Tacony-Palmyra Bridge prior to testing. **02** PhD student and Pennoni employee Matthew Yarnold gains access to the arch of the bridge. **03** PhD student Adrienne Deal installs accelerometers prior to an ambient vibration testings. **04** An installed accelerometer on a bridge bearing. **05** PhD student John DeVitis manages incoming data during testing. **06** An installed accelerometer on a bridge bearing. **07** View of bridge pier through the bridge underside. **08** Arch of the Tacony-Palmyra Bridge viewed from the operator's tower. **09** Yarnold and PhD student David Masceri access the arch during sensor installation.





BIOLOGY

_ONLINE
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_AN ALZHEIMER'S CURE–FOR FRUIT FLIES

With the help of the tiny ***fruit fly,*** *Drexel's Felice Elefant aims to speed up science's understanding of Alzheimer's.* _by Lini Kadaba

_FELICE ELEFANT
Elefant is an associate professor in the Department of Biology.

DREXEL UNIVERSITY BIOLOGIST Felice Elefant has discovered a novel way to control sleep disruptions—believed to be an early sign of Alzheimer's and other neurodegenerative diseases—that could one day lead to new therapies. This research on a unique line of *Drosophila*—fruit flies—made the recent cover of the journal *Genetics*.

Memory loss due to normal cognitive decline is a serious, widespread concern as the population ages. Currently, the United States has approximately 38 million people 65 or older. By 2030, that number is projected to soar to 70 million people, many of whom will suffer from neurodegenerative diseases.

"We have to find a way to deal with these cognitive defects," says Elefant, an associate professor of biology and co-associate head of the Biology Department.

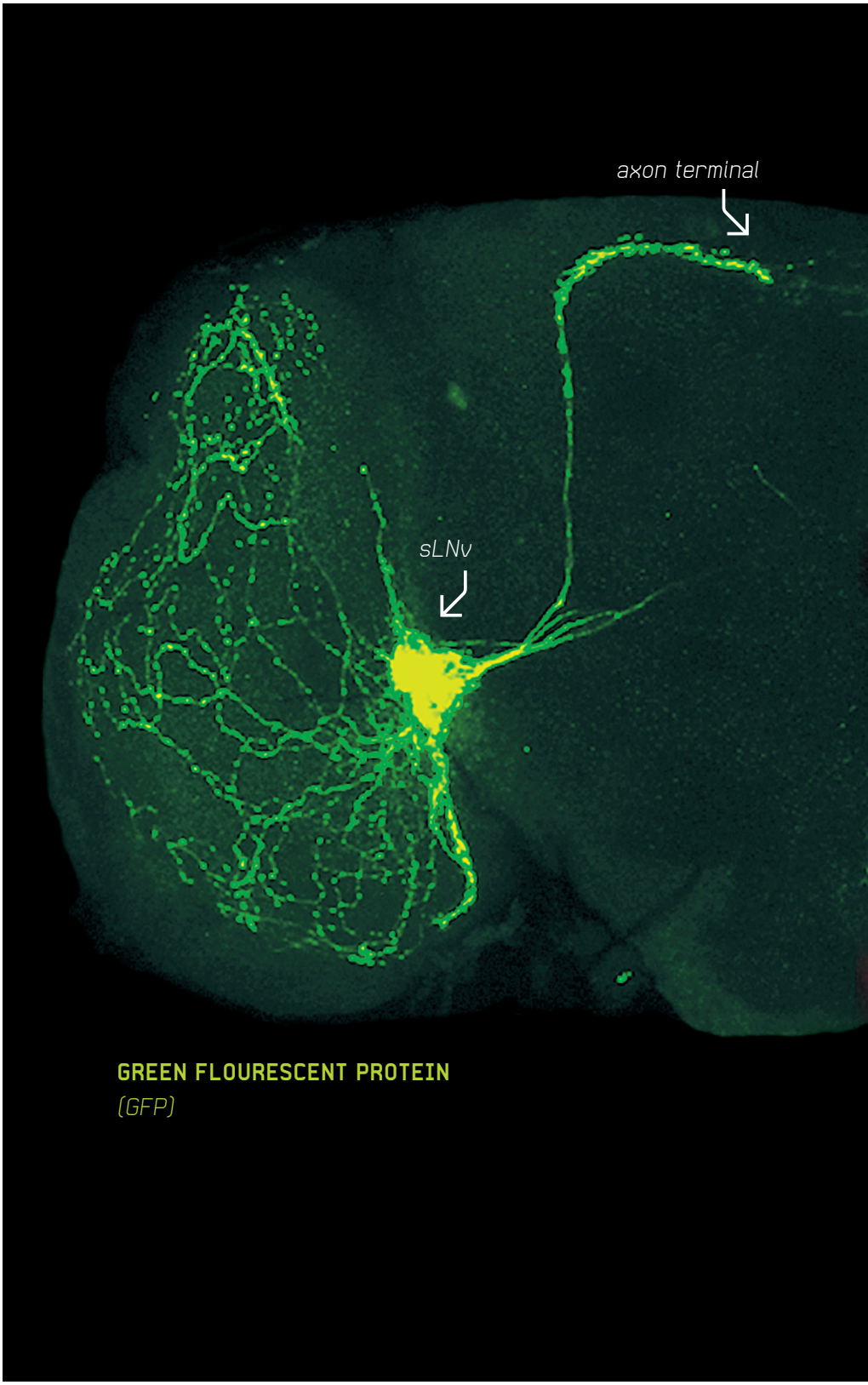
Her research, funded through two National Institutes of Health grants totaling $1.5 million, has helped to advance understanding of the mechanisms at play in the field of epigenetically-regulated genes, particularly those involved in neurodegenerative decline. The relatively new field of epigenetics maintains that the environment around us—whether it's the food we eat or the stress we experience—can actually change genes and how they behave. Elefant has focused on environmental stimuli that affect the brain's synaptic plasticity and ultimately its ability to make connections between neurons and thereby retain memories. This is particularly relevant to Huntington's, Parkinson's, Alzheimer's and other neurodegenerative conditions.

Underpinning her research, she says, is the question, "How does experience shape our cognitive ability?"

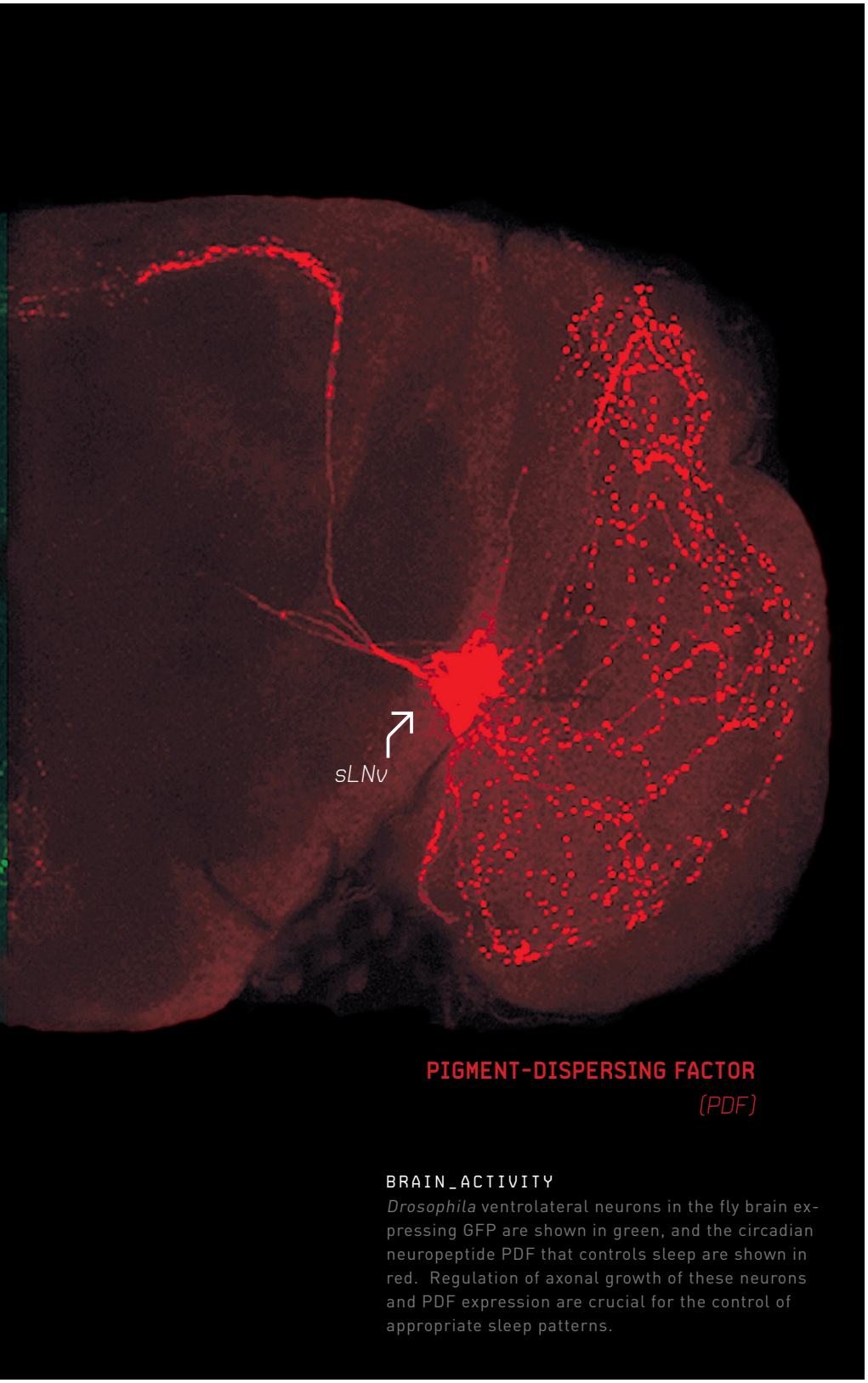
In earlier work, Elefant's lab discovered that the protein Tip60, a histone acetyltransferase enzyme, or HAT, regulates how well sleep/wake neurons function, at least in fruit flies. (It likely reflects what happens in us too because fruit flies have a sleep/wake cycle similar to the one in humans, down to the circadian rhythms.)

Tiny chemical markers, responding to the environment, act as writers, readers and erasers on the histone, continuously changing the way the DNA is packaged or wrapped around the histone.

"The environment is impacting what enzymes are being produced and activated," she says. "Our synaptic activity, our injuries, stresses, environmental stimuli all feed into this enzymatic, epigenetic machinery of writers and erasers."



GREEN FLOURESCENT PROTEIN
(GFP)



BRAIN_ACTIVITY

Drosophila ventrolateral neurons in the fly brain expressing GFP are shown in green, and the circadian neuropeptide PDF that controls sleep are shown in red. Regulation of axonal growth of these neurons and PDF expression are crucial for the control of appropriate sleep patterns.

This latest research studied whether manipulating the amount of Tip60 in a fruit fly disease model for Alzheimer's—a model developed at her lab—can fix sleep issues that precede a neurodegenerative diagnosis. Elefant and her students—including former doctoral student Sheila K. Pirooznia, now a post-doc at Johns Hopkins University—collaborated with John E. Zimmerman, a researcher at Center for Sleep and Respiratory Neurobiology at the University of Pennsylvania.

The bottom line? Yes, it can. The notable finding potentially opens the door to new, targeted therapies. In addition to its feature in *Genetics*, the study will appear in a forthcoming commentary in the journal *Fly*.

In healthy flies where Tip60 can be manipulated, loss of HAT activity stunted the growth of small ventrolateral neurons, which is harmful to a normal sleep/wake cycle in the fruit flies. At Penn's Center for Sleep and Respiratory Neurobiology, the flies without Tip60 HAT activity were videotaped round the clock.

"What we found was really remarkable," Elefant says. "The flies have fragmented night sleep, and sleep too much during the day. That's just like the subtle, early effects of Alzheimer's disease in humans."

Next, Tip60 was manipulated in flies that produced amyloid precursor protein, which leads to the plaques that characterize Alzheimer's. Once again, taking out Tip60 shortened neurons by suppressing the production of the neuropeptide pigment-dispersing factor, or PDF, in flies. (PDF is equivalent to the neurotransmitter hypocretin in humans.)

But what proved really exciting was that overexpressing Tip60 HAT activity increased PDF in the Alzheimer's flies and made the neurons grow spectacularly, which in turn ameliorated the sleep/wake problems.

"That shows a neuroprotective role for Tip60 in this disease," she says, "supporting the concept that if we modulate specific writers, and Tip60 is one of them,

"What we found was really remarkable. The flies have fragmented night sleep, and sleep too much during the day. That's just like the subtle, early effects of Alzheimer's disease in humans."

this could be some kind of therapy." This is particularly significant because the majority of current epigenetic-based therapies target the erasers—a scattershot approach that can cause harmful side effects.

Next up in her research, says Elefant, is the study of whether these sleep defects are a cause or consequence of memory problems. (In fruit flies, she says, there appears to be a causal effect.) She also wants to better understand the mechanism by which Tip60 works to protect against Alzheimer's in the disease model and the role of the environment on synaptic plasticity.

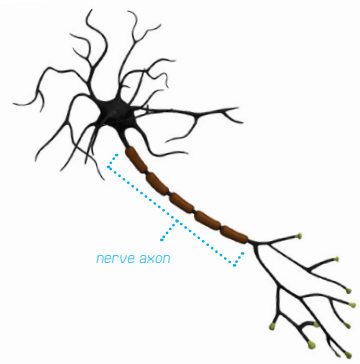
NEUROBIOLOGY

_SPEEDING HEALING

_JEFFERY TWISS
Twiss is a professor and in the Biology Department in the College of Arts and Sciences.

One molecule makes nerve cells grow longer. Another one makes them grow branches. These new experimental manipulations have taken Drexel researchers a step closer to understanding how nerve cells are repaired at their farthest reaches after injury.

"If you injure a peripheral nerve, it will spontaneously regenerate, but it goes very slowly. We're trying to speed that up," says Jeffery Twiss, a professor in the the Biology Department in Drexel's College of Arts and Sciences.



SECRET_'RECIPE'
In the experiment, the "standard recipe" of mRNA, which directs cells to make proteins in the cell body, didn't have the effects on the axons' growth as compared to the "local recipe."

Christopher Donnelly, now a postdoctoral fellow at Johns Hopkins University, led the study as part of his dissertation work in Twiss' lab while at the University of Delaware.

Donnelly and Twiss knew from their previous research that two of the messenger RNA molecules involved in directing repair in injured axons compete against each other at an essential step in repairing damage. The mRNA molecules that "win" the competition get to make their particular repair-protein product.

So, experimentally, they rigged the competition between those molecules to see what would happen: Could one molecule make a difference in helping axons grow longer, faster?

The technical process of these experiments was complex, but the answers were clear.

They saw more branches in the axons when they added more mRNA used to make the repair protein beta-actin, while taking away the mRNA for the protein GAP-43. But they got the desired longer, less-branched axons from the opposite experiment, adding mRNA coding for GAP-43 and taking away that for beta-actin.

This was a promising result for developing potential therapies, Donnelly says. When nerves repair themselves after injury, there is currently no way to control their pattern of regrowth. But, "if you can induce longer growth quicker, rather than branching growth, you can help reach the target of faster recovery from an injury."

SPORTS MEDICINE

_HEAD STRONG

*Using **vibrotactile technology** on a portable device, associate dean Eugene Hong believes he and researchers at Drexel could bring more understanding to the mysterious nature of concussions.*

Whatever you do, don't call Eugene Hong an expert on concussions.

"I'm a student of concussions, I'm not an expert on concussions," says Hong, the associate dean for Primary Care and Community Health and chief of the Division of Sports Medicine at the College of Medicine.

Though he has been lecturing, writing and researching concussions for the past 12 years and has even published a medical school textbook chapter on the subject, he says he's been "struggling" with the mysterious and evasive nature of concussions.

"In the area of concussions, we actually have a lot of questions and very few answers. There's a fair amount of expert opinion out there but there's not a lot of hard evidence in the research aspects of concussions," Hong says.

Hong believes that his research using vibrotactile technology on a portable device that could be used to diagnose concussions earlier will help bring more understanding to the topic. And the Department of Defense agrees, as it has given funding and the actual device to Hong in the hopes that it could be used on the field in military combat.

_EUGENE HONG
Hong is the associate dean for Primary Care and Community Health for the College of Medicine and chief of the Division of Sports Medicine.

TESTING_ATHLETES
While it is difficult to find volunteers, Hong has tested the device on 11 subjects with sports-related concussions.

The device contains an array of seven sensors strapped across the patient's forehead that applies a light pressure in a specific pattern. Concussions alter a person's tactile ability to sense the pattern, so a concussed person would not be able to sense and repeat the pattern like a non-concussed person would.

Hong says he believes that if the portable device succeeds in appropriately diagnosing concussions earlier, the DoD will be able to use it in military settings and fields. He also believes that the device would be able to test blast-related military concussions in a similar way that it is currently being used to test sports-related concussions.

Hong says balance is usually a key factor in determining concussions, but devices used to test balance are not portable. Clinical diagnosis relies on medical history and exams, not a black-and-white blood test or an imaging test that instantly determines whether someone's been concussed.

BIOMEDICAL ENGINEERING

_THE POWER OF LIGHT

Drexel researchers are working to solve a problem endemic to ***long-term care facilities****: Exposure to endless ambient light.*

CAN YOU IMAGINE A LIFE without sunsets? Twenty-four hours of daylight? Probably not.

But constant light and unnatural lighting patterns are relatively common in hospitals and group-living centers. These situations disrupt sleep patterns, cause disorientation and throw off basic bodily function, and now a team of Drexel researchers is working on a solution that brings the benefits of natural light inside with the flip of a switch.

Drexel's Don McEachron and Eugenia Ellis note that while hospitals and living centers are designed to keep patients in a safe, comfortable, sterile environment, a consideration that sometimes goes by the wayside is residents' exposure to natural light. Ambient, artificial light in these facilities allows health care workers to conduct their jobs and monitor residents day and night. But McEachron and Ellis believe the residents could experience a much better quality of life and benefit from the improved health that comes with exposure to a regular daylight cycle.

"To keep organisms aligned both inside and out, circadian rhythms—using what is sometimes called a 'biological clock'—synchronize to the daily cycle of light and darkness. In artificial or built environments, constant or unpredictable lighting can cause a failure of alignment and contribute to a loss of temporal health. Humans that are 'out of tune' are more susceptible to a variety of problems, issues and disorders," McEachron says.

> "In artificial or built environments, constant or unpredictable lighting can cause a failure of alignment and contribute to a loss of temporal health."
>
> *Don McEachron, research professor*

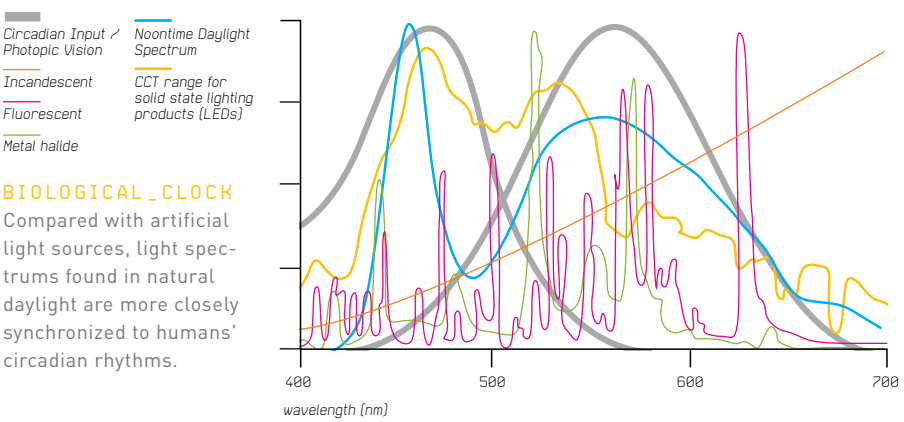
Their solution is a two-foot-square LED light fixture that can be adjusted to mimic the changing color and intensity of natural sunlight, thus simulating a natural day-night light cycle inside the health care facility.

Ellis, who holds appointments in both the Westphal College of Media Arts & Design's Architecture & Interiors Department and the College of Engineering's Civil, Architectural and Environmental Engineering Department, is designing the light. McEachron, a research professor and associate director in the School of Biomedical Engineering, Science and Health Systems, is providing the circadian know-how to tune them so they are in sync with the natural light.

The "daylight" fixtures will get their first trial run at the St. Francis Country Day Home, a senior living facility in Delaware County. Ellis is currently finalizing a prototype and hopes to have the lights installed at St. Francis this summer.

A prototype of the daylight-matching luminaire is being tested in a lab in Drexel's College of Engineering.

McEachron will work with Elizabeth Gonzalez, a professor in the College of Nursing and Health Professions, to conduct a comparative study over the course of several months to monitor the effect of the lights on the patients' sleep habits, energy levels and overall quality of life.



BIOLOGICAL_CLOCK
Compared with artificial light sources, light spectrums found in natural daylight are more closely synchronized to humans' circadian rhythms.

NEUROENGINEERING

_ANATOMY OF RECOLLECTION

Where does a ***"memory"*** *actually come from? A team of researchers from Drexel's School of Biomedical Engineering is trying to find out.*

WHAT WAS YOUR HIGH school mascot? Where did you put your keys last night? Who was the first president of the United States? Groups of neurons in your brain are currently sending electromagnetic rhythms through established pathways in order for you to recall the answers to each of these questions.

Joshua Jacobs, an assistant professor in Drexel's School of Biomedical Engineering, Science and Health Systems, is analyzing data accumulated from 60 epilepsy patients who have had electrodes implanted on their brains in order to determine the causes of their epileptic episodes.

"When performing seizure mapping, surgeons implant electrodes in many brain areas, while searching for seizure activity," Jacobs says. "Thus, many electrodes end up being in normal brain tissue, and they measure neuronal activity that reflects normal brain function."

This type of study is unique because researchers are essentially looking at a more detailed picture of the brain than those generated from the more common electroencephalogram, or EEG, and magnetic resonance imaging, MRI.

"Because the electrodes are implanted directly on the brain surface, inside of the skull, they measure brain activity more precisely than noninvasive techniques, such as EEG or MRI," Jacobs says.

Jacobs equates his research technique to using a set of microphones to record an orchestra. If each microphone is positioned right next to an individual instrument, it gives a better recording than if the microphones are outside the building.

Jacobs and his research assistants are monitoring patients' memory-related brain activity in two ways.

_JOSHUA JACOBS
Jacobs is an assistant professor in the School of Biomedical Engineering, Science and Health Systems.

For some subjects, they record brain activity near the electrodes while asking the patients a series of questions designed to make them use their active memory. The prompts include exercises such as reciting a sequence of letters or numbers or remembering information about sets that are presented to them. The process of coming up with these answers activates the parts of the brain responsible for working, or short-term, memory.

For other subjects, the researchers add electric stimulus to various sets of electrodes while questioning the patient and recording the effects of the administered stimuli on the patients' responses.

NEUROBIOLOGY

_FOCUS ON FOCUS

Actively engaged in research for more than 30 years, the Waterhouse Laboratory at Drexel employs a broad variety of techniques to address fundamental questions in behavioral neurobiology. Barry Waterhouse, the lab's founder, keeps the focus on the central monoaminergic systems in the brain —in particular, the norepinephrine and serotonin transmitter pathways.

_BARRY WATERHOUSE
Waterhouse is the vice dean of Biomedical Graduate and Post-Graduate Studies and a professor of neurobiology and anatomy in the College of Medicine.

Norepinephrine and serotonin are primarily neuromodulatory agents involved in regulating neural circuits in the brain according to the behavioral demands placed on the organism. Waterhouse explains that norepinephrine is high during behaviors that require the organism to be alert and attentive to environmental cues—"when you are in situations that require focused attention," he explains, "working on a math problem, driving a car, flying an airplane." This system is less active when a person becomes drowsy or falls asleep.

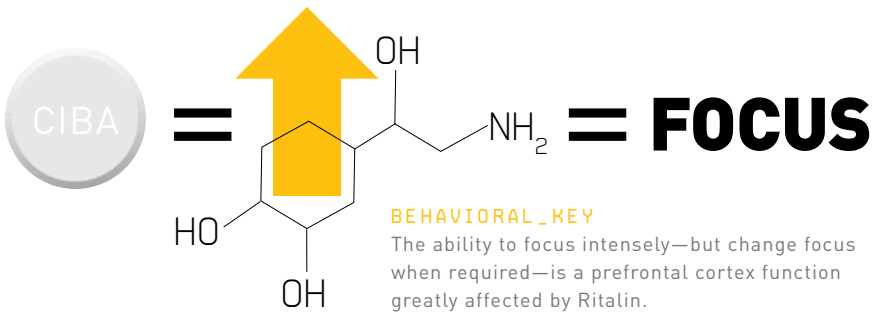
Serotonin, on the other hand, is associated with maintaining homeostasis in brain circuits. There is not an exact correlation to behavior, but Waterhouse notes that the serotonin system has been linked to stress, anxiety and post-traumatic stress disorder.

The serotonin and norepinephrine systems are often implicated in a variety of neuropsychiatric disorders and the drugs used to treat these conditions have major influences on the operations of these pathways. Zoloft and Prozac elevate serotonin levels in the brain, while drugs like Ritalin—commonly prescribed for treating Attention Deficit Hyperactivity Disorder—elevate norepinephrine in the brain.

Currently, researchers in the Waterhouse Laboratory are interested in understanding the basic anatomy, physiology and molecular biology of the norepinephrine system and what role it plays in sustained and flexible attention. As it turns out, norepinephrine via the actions of Ritalin regulates rodent performance in laboratory tests of attention. In a sustained attention task, rats are required to remain vigilant to a light cue in order to receive a reward. In the flexible attention task the experimenter periodically changes the rules of the test so that the rat recognizes it must change its behavior in order to receive a reward—in other words, the rat has to be flexible in its cognitive ability.

The research team has discovered that rats perform better in both tasks, supporting the idea that Ritalin improves cognitive function regardless of an ADHD diagnosis. Unfortunately, this can lead to off-label use of the drug as an increasingly popular cognitive enhancing agent.

Though Waterhouse and his team are extensively studying the effects of Ritalin on the norepinephrine system, the greatest focus of this effort is on the prefrontal cortex. Waterhouse explains, "[The prefrontal cortex] is the seat of executive function—assigning value to our actions, making decisions, and attending to things when we're supposed to." Importantly, this area of the brain also allows us to "change our strategies so we don't perseverate on tasks at the exclusion of attending to other important activities or events."



BEHAVIORAL_KEY
The ability to focus intensely—but change focus when required—is a prefrontal cortex function greatly affected by Ritalin.

CELL BIOLOGY

_THE AGE FACTOR

Aging cells could be key to understanding and treating ***Alzheimer's***

Scientists at the College of Medicine have discovered that a natural mechanism the body uses to fight against cancer could be the reason brain cells in people with Alzheimer's disease deteriorate so rapidly.

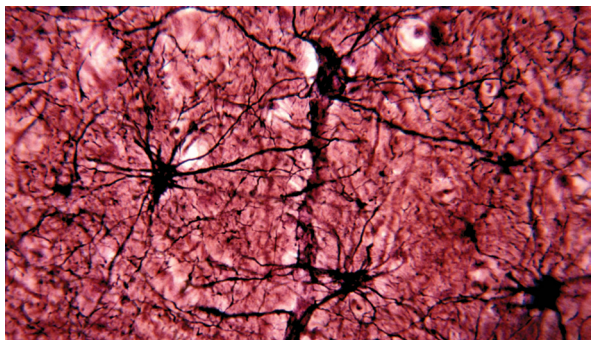
Claudio Torres, a research associate professor in the College of Medicine and his team recently published findings in the open access journal *PLOS ONE* from a study that looks at astrocytes—star-shaped cells that make up more than 80 percent of the human nervous system—and the impact these cells have on the brain as they age.

Astrocytes are important communicators with the neurons in the brain—they are present in the human brain even before birth. These cells hold neurons in place, get nutrients to them and even digest parts of dead neurons.

"For a long time, people thought astrocytes were just like a glue for the brain to keep the neurons in place," Torres says. "But in the last 10 to 15 years, we're realizing these cells really play multiple functions—they help the whole brain."

As we age, so do the astrocytes, and those that start to "senesce," or cease replication, stop their usual and beneficial maintenance of the brain and instead become harmful. Senescence is believed to have evolved in the human body as a natural anti-cancer mechanism, Torres says. Senescent cells produce toxins and profoundly damage nearby cells that might have been affected by those toxins, an action that at one time may have been beneficial for fighting off cancer cells. But what may be considered helpful for fighting one disease could be accelerating another, Torres says. In the paper, he and his team suggest that an accumulation of these senescent astrocytes may link increased age and increased risk for sporadic Alzheimer's disease.

Two years ago, Torres and his colleagues tested brain samples from fetuses, and from healthy individuals ages 35 to 50, and ages 78 to 90 in search of senescent astrocytes. They found healthy brains from those subjects over 35 had up to eight times more senescent cells than fetuses.



CELL_ACCUMULATION
In studying Alzheimer's greatest risk factor, aging, Torres says the key is to understand that senescent cells accumulate in life and to focus on their altered secretory pattern.

_BRAIN IMAGING

With new technology, Drexel researchers are able to study the mysterious human brain with more accuracy and less equipment.

Until a few years ago, the most common way to collect information about the brain was to use magnetic resonance imaging, or MRI, which is used for structural measuring rather than brain activity.

These days, Drexel researchers such as Hasan Ayaz, an assistant research professor in the School of Biomedical Engineering, Science and Health Systems, are at the forefront of collecting data with new, smaller methods of brain imaging technology.

"An MRI is a room-sized instrument in hospitals, and while we have learned a lot from MRI, there are constraints," Ayaz says. "You need to lay down in a small, confined space, and you need to stay still so they can measure the brain."

"We are now able to learn more information about the brain and how it works, but it's a challenge," Ayaz adds. "You need the technology to do so."

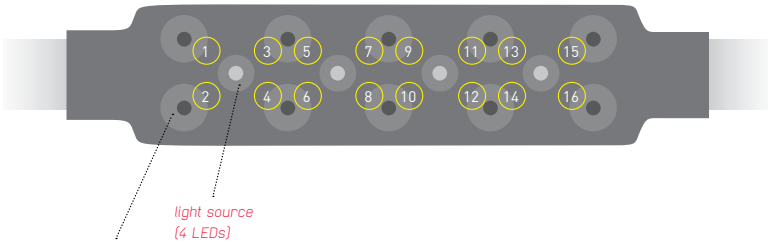
Using smaller, portable devices such as electroencephalography, or EEG technology, and near-infrared-based functional optical brain imaging, or fNIR, Ayaz and researchers at the Cognitive Neuroengineering and Quantitative Research Collaborative are able to capture information about the brain in situations that more closely mimic real-world activities. The EEG and fNIR can be used separately or in tandem to create a more comprehensive picture of brain activity.

MEASURING_UP

Using fNIR technology, researchers monitor tissue oxygenation in the brain while the subject performs cognitive tasks. Researchers can analyze brain functions such as attention and memory.

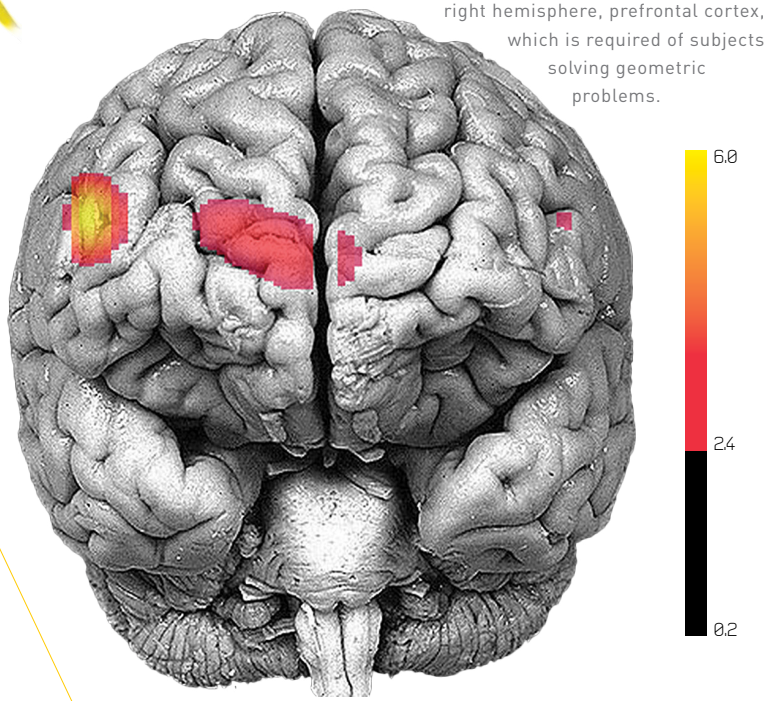
BRAIN_BAND

The fNIR sensor, which resembles a headband, is placed on users. Using four LEDs that shine near-infrared light and 10 photo-detectors, the sensor band samples from 16 brain areas.



BRAIN_OXYGENATION

In brain activations measured by fNIR technology, red spots indicate higher activation areas. This measurement shows involvement of the right hemisphere, prefrontal cortex, which is required of subjects solving geometric problems.



_fNIR device

_EEG device

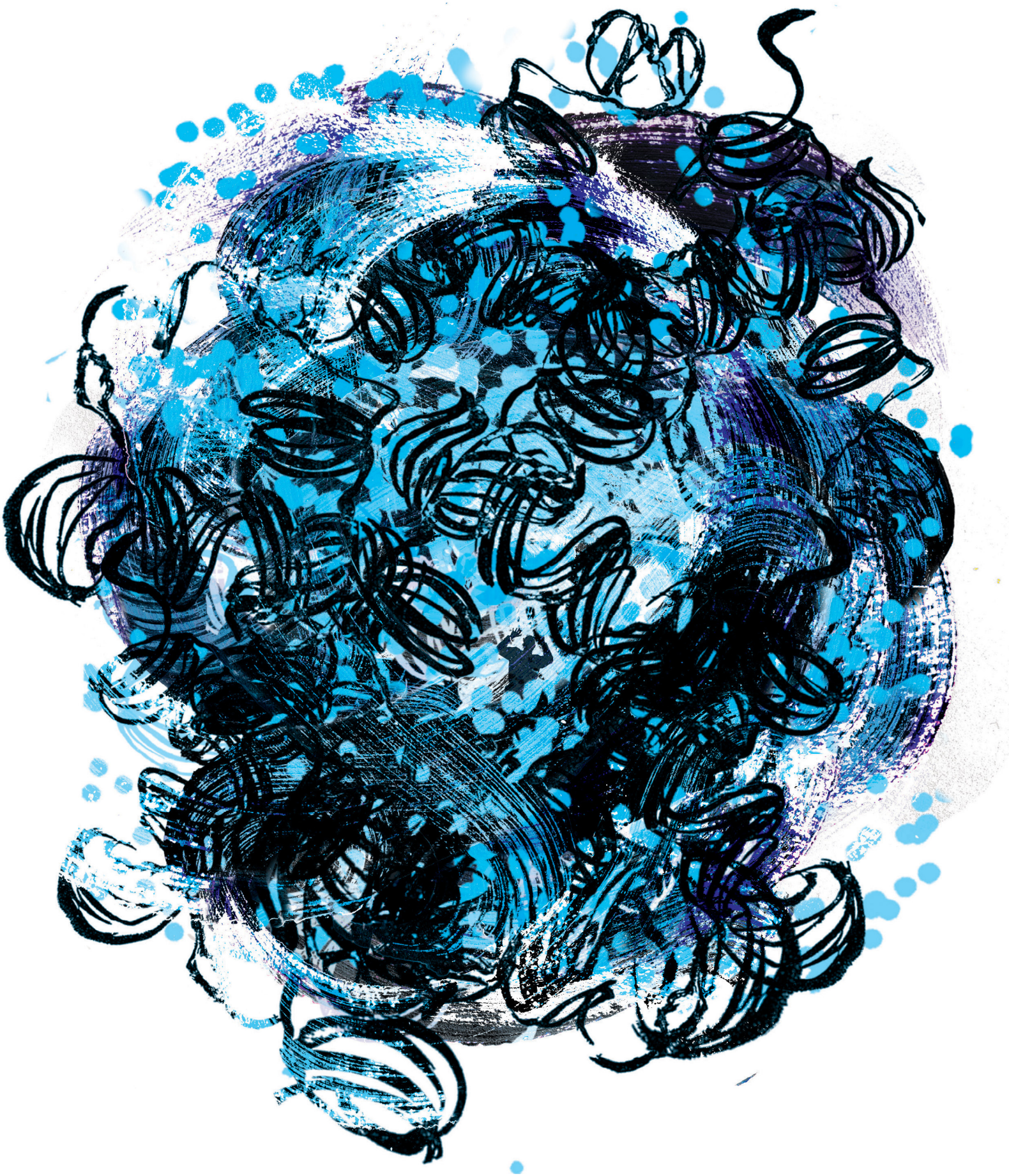
each line represents the measurements of one electrode

CHARTING_THE_BRAIN

EEG technology records electrical activity along the scalp to measure voltage fluctuations resulting from ionic current flows within the brain's neurons.

BRAIN_CAP

EEG technology records electrical activity along the scalp to measure voltage fluctuations resulting from ionic current flows within the brain's neurons.



GOING VIRAL

_by Brian M. Schleter / illustrations by Simon Pemberton

JEFFREY JACOBSON WAS AMONG THE FIRST PHYSICIANS TO TAKE ON HIV/AIDS, AND OVER THE PAST 30 YEARS, HE HAD MADE DEFEATING THE DISEASE HIS LIFE'S WORK. AS HIS MOST RECENT WORK HAS SHOWN, HE AND HIS COLLEAGUES WORLDWIDE ARE GETTING VERY CLOSE TO ACHIEVING PRECISELY THAT.

_JEFFREY JACOBSON
Jacobson is chief of the Division of Infectious Diseases and HIV Medicine at the College of Medicine.

The first time Jeffrey Jacobson stared into the eyes of an AIDS patient, the disease that was ravaging the victim's body didn't yet have a name. The year was 1981, and Jacobson, then a fellow at Mount Sinai Hospital's School of Medicine in New York City, was studying to be an infectious disease expert.

Maybe it was a fortunate circumstance; a right place, right time type of coincidence. But the emergence of human immunodeficiency virus at a time when he was starting his medical career presented Jacobson and other young physicians like him with a unique opportunity to rewrite the rules for treating patients with chronic infections.

"Suddenly it fell upon us and others to take care of this whole new group of patients," says Jacobson, who now is chief of the Division of Infectious Diseases and HIV Medicine at Drexel. "Many of us started inpatient and outpatient programs to treat people and study the disease. First we had to figure out what it was. When the virus was discovered, we had to figure out how it was doing its damage and causing all the complicating infections, and develop ways to treat it."

Despite many medical advances in the treatment of HIV patients, there still is no cure or vaccine for HIV and some 30 years after his career started, Jacobson continues to help patients manage their HIV.

Drexel Medicine's Partnership Comprehensive Care Practice is the largest HIV patient care center in Philadelphia, but there was little clinical research taking place there when Jacobson arrived six years ago. Since then, Jacobson landed in excess of $10 million in National Institutes of Health funding for a series of studies on improved HIV treatments, novel medicines and potential vaccines. All of the work has but one goal: finally and forever putting an end to the AIDS epidemic.

A FRUSTRATING START

Pharmacological advances, increased HIV testing and greater public awareness of how HIV disease is spread have helped stabilize the rate of infection and prolonged life expectancy in industrialized countries like the U.S., where resources are plentiful. But HIV remains an almost certain death sentence in many poorer countries and regions of the world, where infection rates and disease burdens are highest. The World Health Organization estimates there were 34 million people living with HIV/AIDS worldwide in 2011, and there were 1.7 million AIDS-related deaths that year.

IN THE EARLIEST DAYS OF the epidemic, Jacobson found that treating his patients also meant confronting issues of HIV stigma and discrimination. He lobbied to increase access to appropriate medical care for infected prisoners. He convinced a PTA group there was no public health danger in allowing an HIV-infected child to attend school. All the while, he and others sought to better understand why the human immune system was not effective at controlling this highly challenging and lethal virus.

"It was very frustrating in the beginning as there were no effective treatments. And because HIV was a viral infection, it wasn't clear whether there could be very effective treatments anytime soon," he says.

In tandem with the race to develop safe and effective antiviral agents to kill the virus, infectious disease researchers started looking at different vaccine approaches and ways to manipulate the immune system to make it more active against HIV. The purpose of these early studies was to try to pinpoint immune system deficiencies and determine whether they could be reversed.

"We've always been interested in understanding the immunology of HIV disease and seeing if we can improve the immune response," Jacobson says. "We wanted to know, 'Why was the immune system not effective at controlling this virus, unlike other self-limited viral illnesses that we get?'"

"Pills have really penetrated the market. We've seen what they can do and they've saved lots of lives and they've been really phenomenal at turning the epidemic around. But they're just not enough."

-Richard Trauger, chief scientific officer at CytoDyn

Antiretroviral therapies now in use have been successful at suppressing the virus but do not eradicate the virus from the body. Drugs are designed to attack the virus once it's invaded healthy cells by affecting enzymes the virus needs to complete its lifecycle. Drug resistance, adverse side effects and toxicities from long-term use remain challenges to managing patients' care with pills.

OLD SCIENCE, NEW APPROACH

One aspect of Jacobson's research focuses on an alternative antibody-based approach to treating HIV infection. Antibodies, also called immunoglobulins, are proteins that circulate in the blood stream. They are a natural part of the immune system, helping fight off foreign pathogens that cause disease. When HIV antigens enter the body, the immune system activates white blood cells to create and send out HIV-specific antibodies.

Early antibody-based HIV studies conducted by Jacobson involved collecting hyper-immunoglobulins from the blood of healthy patients and using them to treat patients with more advanced disease. An established practice for more than 100 years, this was an attempt to neutralize the virus. Later, single antibodies with more specific, targeted activity against HIV were constructed. If the antibodies proved effective, it could lead to new vaccine candidates.

This line of research, Jacobson says, evolved into looking for antibodies capable of inhibiting the virus from attaching to and getting inside new cells. HIV antigen can only adhere to a host cell's outer surface membrane at certain receptor points. By coating these molecules with special antibodies that block HIV—without impairing the receptor's ability to otherwise function—antibodies essentially work like the lock on the front door, denying HIV the key to gain entry to the cell where it can replicate.

Unlike drugs, which can be swallowed, therapies that use antibodies must be delivered either intravenously or subcutaneously. One of Jacobson's NIH studies is a Phase II-b clinical trial to optimize the dosing regimen of a novel monoclonal antibody called Pro140. Three initial clinical studies led by Jacobson showed it to be as antiviral as the best oral agents currently in use. Because it's a molecule produced by the body itself, it's also less toxic. The most innovative feature of Pro140, Jacobson says, is that it's longer lasting than drugs currently on the market. One dose of Pro140 was shown to decrease viral loads for at least one to two weeks.

For HIV-infected patients who struggle to take the daily regimen of antiretroviral pills, Pro140 could be a game changer, Jacobson says. The Centers for Disease Control and Prevention estimated that less than 30 percent of the 1.2 million HIV-positive Americans have been diagnosed and treated successfully to the point where their viral loads are undetectable. The main challenge to achieving this clinical result is patient adherence to taking the medication daily as prescribed.

There can be many reasons for non-adherence. In his experience treating HIV patients, Jacobson says, most are young and they struggle to think of themselves as having a chronic disease. Taking a cocktail of pills every day is a reminder that they are different from others. Within the HIV population are subgroups that have particular difficulties, including intravenous drug users and those abused as children.

"It's hard for anyone to take all their medications all the time but these are people who live disorganized lives to begin with, and that's how they got infected in first place. They are not necessarily motivated to take care of themselves," he says.

STOPPING THE SPREAD OF HIV

Easing the burden of treatment is critical to controlling the spread of HIV because those who engage in high-risk behaviors are at especially high risk of transmitting the virus to others, says Richard Trauger, a former chief scientific officer at CytoDyn, which is hoping to bring Pro140 to market.

"If we can keep people on the therapy, even if they drift off and don't take their pills, we've still got coverage and

we're managing this disease better from an epidemiological perspective," he says. "Pills have really penetrated the market. We've seen what they can do and they've saved lots of lives and they've been really phenomenal at turning the epidemic around. But they're just not enough. You can't give them another pill to solve the [adherence] problem."

Additional research on Pro140 will explore whether it potentially could be used to block new infections in people for short periods of time, a concept called protective immunity, Trauger says. The earlier clinical studies led by Jacobson show P140 antibodies can remain on cells targeted by HIV for up to 45 days.

During Jacobson's other NIH Phase II clinical trial, 76 HIV-infected patients who abuse substances and have not been successfully treated with oral drugs will receive a standard drug regimen plus a dose of P140 or a placebo to determine if P140 improves the antiviral response. Researchers will monitor the patients for six months to see if their viral loads reach non-detectable levels.

"Now there's even more interest in going for a so-called cure," Jacobson says. "I think the most realistic approach is to go for a functional cure where you don't fully eradicate the virus, because that's going to be a tall order."

MAKING PEOPLE SICKER, TO MAKE THEM BETTER

Meanwhile, the search for an effective vaccine continues. Developing a universal HIV vaccine has proven elusive, in part, because there are many different varieties of the virus.

In an immune system-based intervention Jacobson led through the national AIDS Clinical Trial Group, patients whose viral loads had been stabilized with antiretroviral drugs were exposed to their own virus for a short period of time and were asked to stop taking the drugs. This essentially tricked the immune system into fighting a "new" infection. The process was then repeated several times. By monitoring dropping viral loads until they reached a new, hopefully lower set point, researchers were able to gauge for the first time the effectiveness of this and other immune-based approaches.

The results were encouraging. Those who were "pulsed" with their own virus achieved modestly lower viral set points. And about 15-20 percent of the treated group attained near undetectable levels—and stayed there for at least a year. Inducing the immune system to control the virus on its own without the need for antiviral drugs would achieve what has been called a "functional" cure.

"The immune system is not really set up to chronically react to an antigen. It's set up to see an invader, deal with it and then create memory cells for when it happens again. Otherwise it goes to rest," Jacobson says. "We thought exposing them again to their own virus for a brief period of time, then treating them to 'slam down' the virus would be a way to pulse the immune system without exhausting it too much."

In another NIH study, Jacobson's lab is using this new tool of monitoring viral set points to explore the idea of taking samples of a patient's virus and using it to create a personalized vaccine. First, researchers take blood samples from HIV-infected patients before they are put on antiretroviral therapies. The samples are stored while the patient is treated. Once the virus is suppressed, white blood cells called dendritic cells are harvested from blood samples of HIV-infected patients through a lab process called leukapheresis. In a normal immune response, dendritic cells act to communicate the presence of a foreign antigen to other immune cells which then attack it.

"Dendritic cells are like the guards outside the castle; they signal to everyone else how to respond when there's an invader," Jacobson says. "They're also known as nature's adjuvant because they boost the response of the immune system to what's attacking the body."

By loading the RNA genetic material of the virus onto these active dendritic cells in the lab and transplanting them back into the person's bloodstream, researchers hope to trigger a stronger, natural immune response, similar to the way vaccines work, but with active disease. This same approach was recently approved to treat prostate cancer, and other research groups are looking at dendritic cell-based vaccines for other types of cancer.

'AN AMAZING ROLLER COASTER RIDE'

As promising as the research appears, only one HIV-positive adult—the so-called Berlin patient—has been considered functionally cured of the disease; that patient received a bone-marrow transplant for leukemia from a donor genetically resistant to HIV infection, but such treatment is cost-prohibitive and unlikely to be replicated en masse. Meanwhile, in another medical first, doctors announced that a 2-year-old Mississippi child born with HIV and treated aggressively with a full regimen of antiretroviral drugs starting just after birth had also experienced a functional cure. The child had been off drugs for a year with no sign of active virus.

The news was promising, but as Jacobson points it, the baby's infection may not have been established yet and the drugs may have merely prevented, and not actually treated, the infection.

"Both cases represent situations that are highly unusual and not typical of the average HIV-infected person. Nevertheless, they provide opportunities to advance our knowledge of the mechanisms underlying persistence of HIV infection, knowledge that could help guide the testing of strategies to cure the infection," Jacobson says.

Each major breakthrough helps rekindle the hope he first felt 30 years ago of helping to find a cure. Great progress has been made in our knowledge and in developing effective treatments for HIV infection.

"It's been an amazing roller coaster ride. There were a lot of ups and downs and a lot of struggles getting patients the care that they needed, helping them deal with the discrimination and stigma," he says. "There were a lot of challenges but also many rewards. To have my career span from my training at the beginning of it all to now is amazing."

PRO140: OVERVIEW

According to the National Institutes of Health, PRO140 is an investigational drug included in the entry inhibitor drug class for the treatment of HIV infection. Entry inhibitors interfere with the first step in the HIV life cycle—binding and fusion to target cells. By preventing HIV from entering target immune cells, entry inhibitors stop HIV from replicating and reduce the amount of HIV in the blood.

MOVING ON

Thanks to significant strides in HIV research, treatments for the disease have proved to be wildly successful. But as HIV-positive individuals continue to live with the disease, scientists are posed with a new challenge–how HIV affects a ***now-aging population.*** *Drexel researchers are at the forefront of finding*

_PROTECTING THE BARRIER

_MICHAEL NONNEMACHER

Nonnemacher is the assistant director of the Center for Molecular Virology and Neuroimmunology and an assistant professor in the College of Medicine.

"We're asking basic mechanistic questions: Is the barrier that regulates the in and out of the brain differently working in an aged versus non-aged person in an HIV-infected model?"

As the HIV-infected population ages, cognitive issues are arising that affect the quality of life for individuals. To tackle this problem, Michael Nonnemacher, an assistant professor in microbiology and immunology at Drexel University, is developing *in vitro* models to study the mechanisms of the blood-brain barrier and the impact of HIV on the barrier's function.

The project also will look at the role aging plays on the barrier's ability to regulate what gets in and out of the central nervous system through the lens of the viral protein Tat, which is secreted from HIV-infected cells. Tat, research has shown, has a role in weakening the blood-brain barrier and causing inflammation in the central nervous system.

"We're looking at it specifically from the genetic variation of a protein that has been shown to impact the blood-brain barrier," Nonnemacher says.

That barrier separates the circulating blood from the brain fluid in the central nervous system and is made up of three compartments: blood, a layer of endothelial cells and astrocyte and pericyte cells in the brain that support the endothelium and effectively tightly stitch together a protective wall.

When working properly, only certain molecules can pass through, such as immune cells that patrol for pathogens, drugs and other small molecules, Nonnemacher says. But in HIV-infected people, the barrier's permeability is disrupted, likely due to cellular changes.

Cells infected with HIV have altered cytokines, which are proteins that help regulate the immune system. They also produce virus particles and secrete Tat.

Tat, in particular, degrades the tight junction proteins, essentially the astrocytes that hold together the endothelial blood-brain barrier, and disrupts the barrier's structure. Once it is damaged, cell migration across the wall increases the quantity of infected cells, viral proteins and viruses that reach the central nervous system.

"As these cells senesce, what we don't know is what kind of loss of function does that provide to the barrier," says Nonnemacher. "Is there a breach? Or is the barrier intact?"

The genetic variation of Tat, related to the HIV virus's hallmark ability to mutate, is an important factor in the severity of HIV-related cognitive deficits. Nonnemacher's project, funded through a $20,000 grant from Temple University's Comprehensive NeuroAIDS Center, will focus on developing cell models to understand how HIV affects the blood-brain barrier and ultimately the central nervous system, particularly in an aging population.

"We're asking basic mechanistic questions: Is the barrier that regulates the in and out of the brain differently working in an aged versus non-aged person in an HIV-infected model?" he says.

Patient data suggest the answer is yes, Nonnemacher says. Once researchers figure out what exactly is going on, then the next question that he hopes to attack is this: "Is there something we can do to fix it?"

_DOUBLE WHAMMY

About 30 percent of people worldwide—more than 10 million individuals—are not only infected with AIDS-causing HIV but also with the hepatitis C virus (HCV). That dual whammy takes its toll on the immune system and may accelerate the aging process in those patients, according to Vanessa Pirrone, a research instructor in the Department of Microbiology and Immunology.

In a new study supported with University developmental funding, she looks at the impact of co-infection on an aging population. The two viruses "can exacerbate one another," Pirrone says. Co-infected patients have more rapid progression of liver disease, as well as higher risks for cardiovascular problems, diabetes and carcinomas.

"In general, you have further waning of the immune system and more immunosenescence," she says. Normally, the immune system in healthy people slows as they reach their 70s, 80s and 90s. But in the HIV-infected population, problems start to arise when they are only in their 50s. Older HIV-infected patients also suffer two to three times the frequency of dementia than younger people with the disease.

Preliminary results from analysis of immune cell and plasma samples from two groups—age 35 and younger and age 50 and older—suggest that co-infection with HCV significantly further accelerates the effects of the aging process in patients with HIV, Pirrone says. She suspects that the two viruses act synergistically by speeding up immune system activation, the excessive and aberrant response of the immune system to HIV that plays a major role in AIDS' progression.

"The co-infected are not quite as healthy as the mono-infected patients," she says. "We're looking to see why that is."

Pirrone's project will investigate the effect of aging on immune-regulating molecules (cytokines and chemokines) as well as on genes, proteins and pathways in those who are co-infected compared to those who are only infected with HIV or HCV.

She will also study different cell populations and determine the mechanisms involved in chronic immune activation and viral immunity in the two age groups.

"It is really untested waters," Pirrone says.

The study is tapping HIV and co-infected patients who are part of the large group that researchers are monitoring through Drexel's HIV/AIDS clinic.

Samples of immune cells and plasma from these patients show that those with only HIV infection show increased viral loads as they age, even when they diligently pursue highly active antiretroviral therapy, or HAART. "You would expect the viral load to go down," Pirrone says, noting that HAARTs have improved lifespans so that more AIDS patients are living into their 50s and beyond. "But the viral load is increasing regardless of the therapy."

_VANESSA PIRRONE
Pirrone is a research instructor in the Department of Microbiology and Immunology.

_BARRY WATERHOUSE
Waterhouse is the vice dean of Biomedical Graduate and Post Graduate Studies and a professor of neurobiology and anatomy in the College of Medicine.

"While the disease is under control, they're starting to experience these cognitive deficits. This is very debilitating, because they're otherwise healthy and in the workforce but their decision-making processes are compromised."

_RATS & 'SENIOR MOMENTS'

Surprisingly, few animal models exist to study HIV infection or antiretroviral therapies on the aging brain. Barry Waterhouse, a professor in neurobiology and anatomy at Drexel, hopes to address that pressing concern through the development of a robust rat model.

Researchers think the mix of drugs used to treat HIV/AIDS or the progression of the disease itself is causing inflammation and neurotoxicity in the brain. While anyone growing older suffers cognitive lapses—those so-called senior moments—HIV/AIDS patients appear to experience exacerbated problems.

"While the disease is under control, they're starting to experience these cognitive deficits," Waterhouse says. "This is very debilitating, because they're otherwise healthy and in the workforce but their decision-making processes are compromised."

Many excellent tissue culture models exist to study these processes, but *in vivo* options are limited. Waterhouse's two-year pilot project, funded with a starter grant of $275,000 from the National Institutes of Health, will adapt a rat model that his lab has used in its study of attention deficit hyperactivity disorder to instead look at cognitive skills in relation to HIV/AIDS and aging.

In this project, the rats, trained to do two tasks that involve the prefrontal cortex, are exposed to viral coat proteins, which envelope the virus itself. "The viral coat proteins are not themselves infectious," Waterhouse says, "but when the virus invades the central nervous system, the proteins become distributed around the brain, and they can generate an immune response from the brain's tissue. That, it's believed, precipitates a series of events that leads to cognitive decline and neurotoxicity."

Two types of attention, sustained and flexible, are being measured.

To evaluate sustained attention, the rats are trained for 2.5 months in a behavioral chamber to recognize whether a dim light that appears for a mere 15 seconds is on or off. If it is on, the rat presses one lever and gets a water reward. If it is off, it presses another lever for its reward.

To measure flexible attention, the rats are trained on a set of rules to retrieve a food reward from a small clay flowerpot. Initially, the animals are trained to key into odor. Once mastered, the odor linked to the reward is changed. Once this new rule is mastered, the reward link is again changed, this time to the digging media in the pot or the textured surface surrounding the pot.

The viral coat protein—gp120 was selected as the most likely culprit—is introduced via surgery into the ventricular system of the brain.

Animals, both adult and aged, will be tested on the cortex dependent behavioral tasks both before and after the infusion of gp120.

Very preliminary results show that adult animals with gp120 have flexible attention deficits, Waterhouse says. "They're slower to change their behavior patterns," he says.

_COGNITIVE SECRETS

The retrovirus that causes AIDS acts like a shape-shifting villain. As HIV replicates over time, random mutations take place in the viral genome—one of the hallmarks of the disease that makes containing and curing it such a challenge.

"We've been very interested in studying viral evolution and the structure of the virus, from the beginning, most earliest stages all the way through the end, when someone dies from immune system dysfunction, the virus in the brain, with neurologic problems," says Brian Wigdahl, chair of the Department of Microbiology and Immunology and the director of the Institute of Molecular Medicine and Infectious Disease.

In a $3.5 million NIH-supported research project, Wigdahl focuses on what happens to the replication process as patients live longer thanks to combination drug therapy. His lab also is interested in how the virus affects the aging process.

To study these issues, blood samples from a large group of patients—more than 500 people—seen at Drexel's HIV/AIDS clinic will be analyzed over time. (It is the largest clinical population being monitored long-term in the Philadelphia area, Wigdahl says.)

In this project, his hypothesis is that viral and host genetic factors account for aging AIDS patients' susceptibility to neurocognitive problems. "My interest is starting to really characterize the molecular architecture of the viral genome," he says. "It's a study of detail."

But the payoff is potentially huge, Wigdahl says. It could lead to therapies targeted at new viral genes and proteins, including those related to cognitive decline. Even though about 30 drug treatment protocols for AIDS already exist, "it is still important to keep developing new therapies because of drug resistance and toxicity," he says.

Wigdahl, who has studied HIV/AIDS since the mid-1980s, also still holds out hope for finding a cure. "That's a major point of emphasis with a number of groups, including our own," he says.

In the U.S., more than 1.1 million people are living with HIV infection, according to the Centers for Disease Control. Researchers estimate that by 2015, half of the infected population will be older than age 50.

"It's a good problem to have," Wigdahl says. "We've taken HIV disease and with antiretroviral drug therapy, we've converted it into a chronic condition."

In response, his research is shifting gears from a younger population of study to an older one, with a focus on how AIDS will progress in that aging environment, where normal declines in the immune system (immunosenescence) and cognitive performance are already underway.

One area of investigation is viral single nucleotide polymorphism, or the genetic variation in a DNA sequence. A person with HIV infection has thousands of viral cells, each with a slightly different genetic makeup, the so-called viral swarm. But interestingly, during the early hours up to a few weeks after initial transmission from one individual to another, "a serious bottle neck occurs," Wigdahl says. "What really gets transmitted to that individual is a single genotype."

_BRIAN WIGDAHL
Wigdahl is a professor and chair of the Department of Microbiology and Immunology.

"We've taken HIV disease and with antiretroviral drug therapy, we've converted it into a chronic condition."

_FRED KREBS
Krebs is an associate professor in the Department of Microbiology and Immunology Department.

_INTRICATE TRANSMISSION

Despite 30 years of study, male-to-female transmission of the virus that causes AIDS is not fully understood. Even less is known about infection risk within an aging population.

Given the global AIDS epidemic among heterosexuals as well as longer lifespans for those with AIDS, a better understanding of HIV transmission and the impact of aging on the disease progression is crucial, says Fred Krebs, an associate professor in microbiology and immunology at Drexel. He has proposed exploring the effect of age on factors in seminal fluid that modulate the female reproductive tract's immune response. That in turn could alter the risk of HIV infection.

"It's an area that has not been studied much at all, in any population, at any age," he says.

Until recently, it was thought that the *static* medium of semen deposited the virus and infected cells into the vaginal environment, from where the disease spread systemically. In fact, semen contains numerous active factors, such as cytokines and chemokines, that prepare women for reproduction by changing the immune response in the female reproductive tract to allow for the foreign antigen, semen.

"The immune system is dialed back to create an environment of tolerance," Krebs says. While good for conception, this process could increase the risk of HIV infection, he says.

In addition, mouse models have shown that the introduction of seminal fluid into the female reproductive tract results in inflammation, which causes the recruitment of immune cells to the area.

"The immune response in the female reproductive tract is really a double-edged sword," Krebs says. "It could increase risk of transmission. It also could decrease risk of transmission." How? More immune cells could fight off an HIV infection, or they could heighten risk by offering more targets for infection.

Aging, it is suspected, further impacts transmission scenarios. It's an important aspect to explore for a number of reasons, Krebs says.

AIDS is no longer a death sentence within 10 years of infection because of effective combination antiretroviral therapies. American society encourages and values sexuality among older people—increasing the risk of transmission among this aged population. Finally, immunosenescence, a natural process in which the immune system deteriorates over time, likely affects the transmission risk of HIV.

In the case of immunosenescence, the body becomes "less efficient in fighting off disease and pathogens and less efficient at controlling infection that has already taken root," Krebs says.

_IN THE RED

As malaria continues to kill nearly 700,000 people worldwide, College of Medicine researcher ***Akhil Vaidya*** *admits the challenges are enormous–but continues to work to eradicate the disease.* _by Brian M. Schleter

_INFECTIONS RISING
Reports of new malaria infections are up 71 percent in Mumbai over the last four years, according to a survey conducted by Mumbai-based Praja Foundation.

In Mumbai, the most populous city in India, the modern day tale of two cities is unfolding. Glitzy, steel and glass apartment towers are rising adjacent to some of the poorest slums in the world. It's the wealthiest city in India, yet like other fast developing cities around the globe, Mumbai also suffers from widespread poverty, unemployment and poor public health.

Because of the tropical climate, female anopheles mosquitoes are ubiquitous, and when they bite, they don't discriminate between the rich and poor. Unlike other metropolitan cities where improvements to public health are strongly associated with economic development, reports of new malaria infections are up 71 percent in Mumbai over the last four years, according to a survey conducted by Mumbai-based Praja Foundation.

A sharp increase in cases of drug-resistant malaria has experts like Drexel Microbiology and Immunology professor Akhil Vaidya especially worried that malaria could be making a comeback in that region.

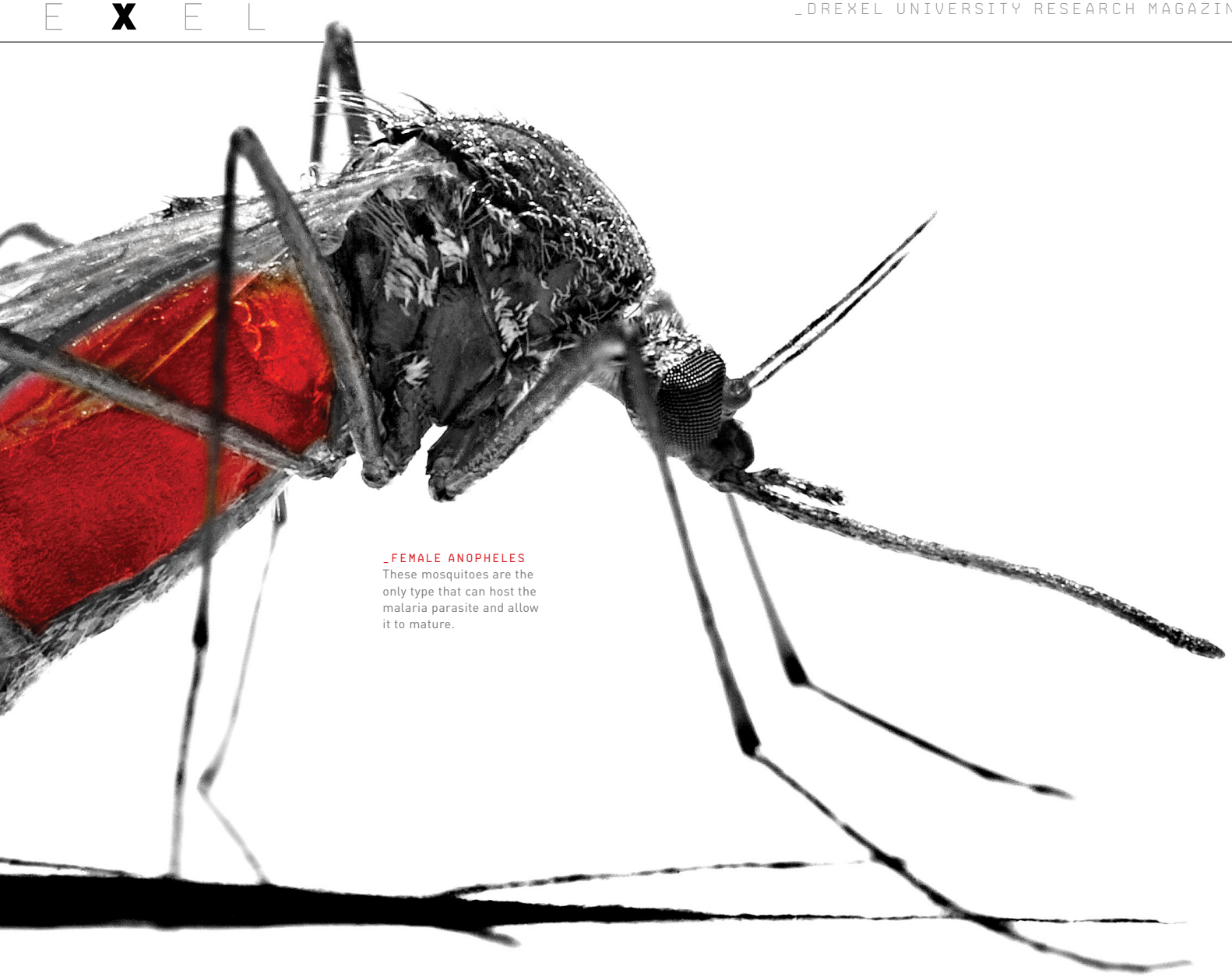
"I visit Mumbai often, and I've seen people who live in apartments who are wealthy get sick and die," Vaidya says. "It's a real problem."

Philadelphia residents were contracting malaria as late as the 1940s, but the disease largely has been eliminated in the United States thanks to better sanitation practices, elimination of standing water and advances in health care. Fewer than 1,400 cases were reported last year, nearly all of which involved people who contracted the disease while traveling abroad.

Malaria disease is caused by parasites that are transmitted to people through the bites of infected mosquitoes. *Plasmodium falciparum* and *Plasmodium vivax* are the most common species of parasite affecting humans; *Plasmodium falciparum* is the most deadly.

The fight against malaria dates to ancient times, yet the disease remains one of the most lethal infectious killers in the world.

As new, drug-resistant strains of the disease emerge and spread across southeast Asia, Vaidya and his colleagues half a world away at the Center for Molecular Parasitology at the College of Medicine are leading groundbreaking efforts to stop it. Vaidya, the center's director, and profes-



_FEMALE ANOPHELES
These mosquitoes are the only type that can host the malaria parasite and allow it to mature.

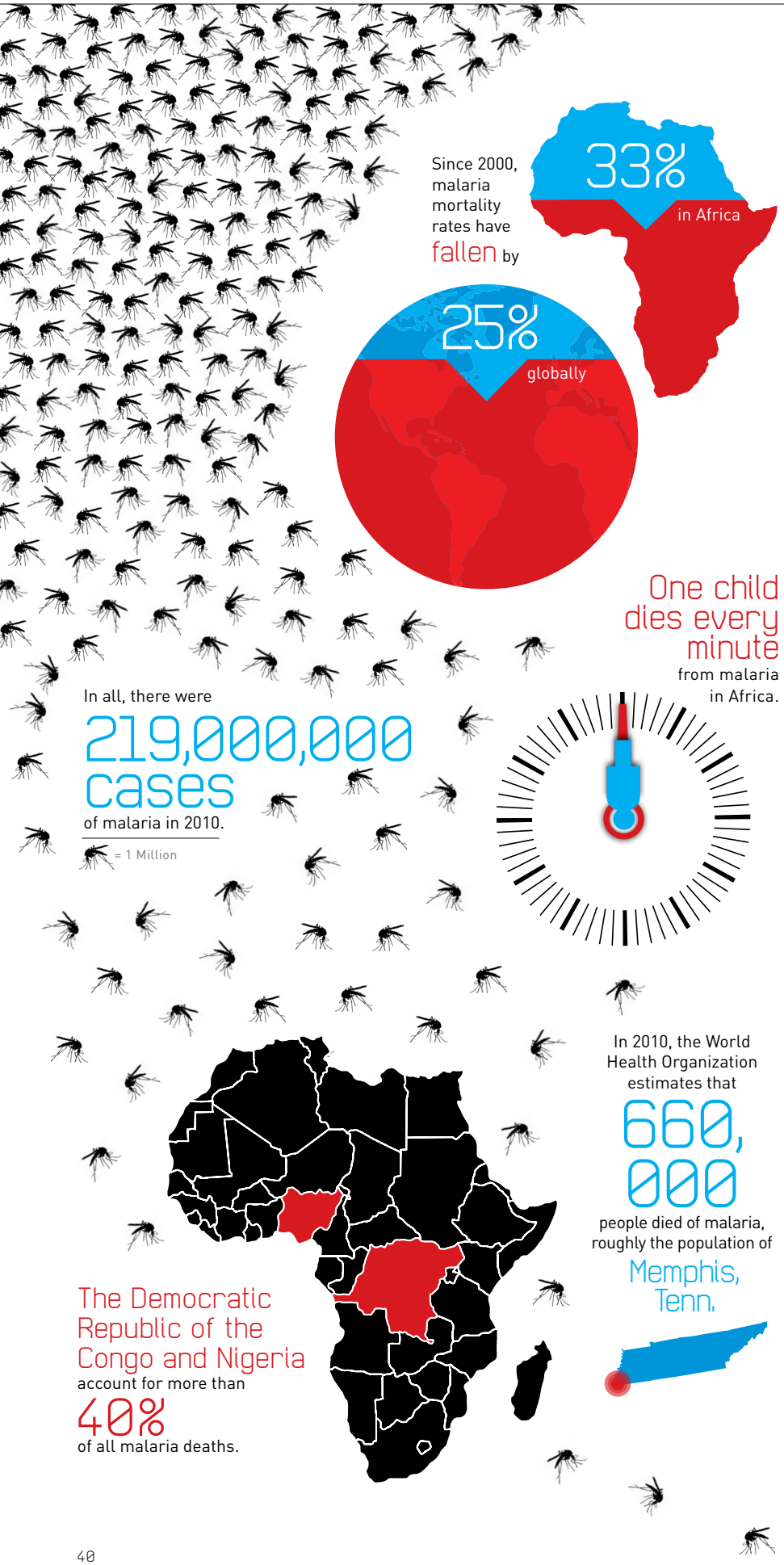
sors James Burns, Bill Bergman and Sandhya Kortagere are probing the complex molecular and genetic structure of the parasites that cause malaria, hoping to discover hidden weaknesses that can be exploited with new, targeted medicines and vaccines. Their efforts, in collaboration with research partners around the globe and made possible in part by a new $2 million grant from the National Institutes of Health, could lead to the development of powerful new tools in the prevention and treatment of malaria.

EFFORTS INCREASE, CHALLENGES REMAIN

Malaria is an entirely preventable and treatable disease. Yet ongoing malaria transmission occurs in 106 countries in the world. The World Health Organization estimates there were 219 million cases of malaria in 2010 and 660,000 deaths were attributed to the disease. Those most at risk include young children, non-immune pregnant women and people with HIV/AIDS. Although 80 percent of cases and 91 percent of deaths occur in Africa, half of the world population is at risk of malaria, according to the Roll Back Malaria Partnership.

The last decade has seen many gains in the fight to control, prevent and treat malaria. Malaria mortality rates have fallen by more than 25 percent globally since 2000. This coincides with a steep increase in international investments in malaria control, up from $100 million in 2000 to an estimated $1.84 billion in 2012. The money has been used to distribute many more insecticide-treated bed nets in sub-Saharan Africa, to increase indoor residual spraying, and to buy and distribute drugs that can prevent infection. Seasonal malaria chemoprevention is a "simple and inexpensive intervention that has the potential to prevent more than 75 percent of uncomplicated and severe malaria among children younger than five years of age," says WHO Director-General Margaret Chan.

Targeting resources to regions hardest hit by malaria has prevented an estimated 274 million more cases and 1.1 million more deaths between 2001 and 2010, according to the WHO's 2012 annual report on malaria, released in December.



Still, major challenges persist. The worldwide economic downturn has meant a leveling off of government funding for malaria research and control efforts—less than half what is needed is available, the WHO says. Disease surveillance is poor in the hardest hit countries. And diagnostic testing rates are nearly the same today as a decade ago.

Vaidya says eradication of malaria is just as simple—and equally as complex—as eradication of poverty.

"If everyone in the world lived in air-conditioned houses with screen doors, there would be no malaria," he says.

Economic issues aside, what has Vaidya and his colleagues very concerned is the emergence of parasite resistance to artemisin, the most effective antimalarial currently in use, in four Southeast Asia countries. Resistance to previous generations of therapies in the 1970s and 1980s undermined malaria control efforts. Child survival rates started decreasing. Now scientists are in a race to understand how the parasite has evolved and prevent similar setbacks.

For Vaidya, the race has been more of a marathon, spanning a 35 year Drexel career. While studying the molecular biology of retroviruses in the 1980s at what was then Hahnemann University, he "got pulled in" to a study on malaria. He never looked back.

His lab looks at the mitochondria functions of malaria parasites to understand how they differ and are similar to host cell mitochondria. In 1989, the laboratory found that the mitochondrial genome of malaria parasites consisted of a very unusual DNA molecule. The breakthrough discovery led to a better understanding of the mechanism of action for antimalarial drugs that were especially effective against *Plasmodium falciparum* parasites, but less so against other varieties. This knowledge helped narrow the choice of which antimalarial drug combinations clinicians should use in patients with a confirmed diagnosis of *Plasmodium falciparum* malaria. It also helped minimize drug resistance.

"What we are doing is essentially making drugs that work as cyanide for the malaria parasite without working as cyanide for us. We are essentially selectively poisoning mitochondria of the parasite without poisoning human mitochrondria. This is possible because the mitochondria of parasites are so very different from host mitochondria in humans," Vaidya says.

In a series of studies that build on these early findings, Vaidya's lab is working to develop new antimalarial compounds. One such venture, in collaboration with investigators at Oregon Health Sciences University, aims to disrupt the mitochondrion function of the invasive parasites. The compound has been nominated as a candidate for clinical development in humans.

Last year, the National Institutes of Health awarded Vaidya's team a $2 million grant for a four-year project to investigate molecular pathways targeted by other promising, new antimalarial compounds identified by his group. He characterizes unpublished data from early lab experiments as "very promising," and one of the agents is slated for testing in humans beginning this year. Over the last three years, the team's drug discovery and development work also has been supported with a $1 million grant from Medicines for Malaria Venture, a non-profit organization based in Geneva, Switzerland.

DREXEL TAKES THE LEAD

As malaria became a major area of research emphasis in the College of Medicine's Department of Microbiology and Immunology, three labs came together in 2001 to form the Center for Molecular Parasitology. With seven faculty members, today it is one of the largest academic groups in the country working to understand, treat and prevent malarial disease.

Bergman's investigations chiefly are concerned with the complex molecular interactions responsible for the disease. A cellular biologist, he is interested in how the parasite manages to invade the host cell, where it lives and reproduces.

"The way the parasite gets into the cell is the same way you get in bed at night. Just as you reach out and grab the covers and pull them over you, the parasite reaches out and grabs the cell it wants to invade and pulls itself using this actin-myosin motor," he says.

Scientists reason that if they could inhibit the motor from latching on to the host red blood cell, they could prevent disease. But the parasites have many of these actin-myosin motors and they have different functions. In fact, numerous parasite and host cell components play a role in the invasion process.

"I always say, 'The parasite is smarter than I am,'" Bergman says. "It is a difficult foe, no doubt."

By laboriously figuring out from a biological point of view what actin-myosin motors do for the parasite, Bergman and Kortagere have potentially identified small molecule inhibitors of the invasion process. The work has led to a collaboration with Kortagere to design small molecule inhibitors that seem to block growth of *Plasmodium falciparum* in lab cultures. The next step is to solicit support to discover how these molecules work and develop them further as potential new antimalarials.

"The goal of any scientist is that the discovery they would make would somehow be implemented into some sort of treatment, and we continue on that quest. In many cases, this is all through an understanding of the basic biology of the parasite."

THE SEARCH FOR A VACCINE

Eradication of malaria, though, would require a vaccine capable of completely preventing infection. Vaccines against all stages of the malaria parasite lifecycle are in development, but none have been approved for use in humans. Progress here has lagged the gains realized by those working on drug development.

"The vaccine side of the house, I have to admit, really hasn't gone as well over the years. Parasites are tough. They have multiple ways of doing things," says Burns, whose lab designs and tests vaccines.

He and his peers are closely watching the results of a Gates Foundation-sponsored Phase 3 clinical trial in humans across 10 sites in Africa, the largest of its kind and "best shot we have going." Early results showed a promising 50-percent efficacy rate. But the most recent data showed the effectiveness dropping to 30 percent for the youngest age group—those most vulnerable to the disease because they lack any natural built up immunity.

From the glass-half-full perspective, some protection is better than no protection at all, Burns says, adding "I think all along it's been recognized that this is a first generation vaccine and we're going to need to improve on it. But we were hoping for better numbers out of the gate."

Different vaccines act to prevent or delay a malaria attack at different stages. Burns' main interest is looking at blood-stage parasites, the point after which they reach the bloodstream and invade host red blood cells. A compound he's developed and tested in rats and rabbits induced strong antibody responses. To predict whether or not it would work well in humans as a vaccine, the team mixed the antibodies that they elicited in animals with blood stage parasites in vitro to see if they could inhibit growth. Parasite growth was notably suppressed.

The next step is an immunization and challenge trial with monkeys, which have been used for decades to test the safety and protective efficacy of potential vaccines and drugs for human use. Burns is collaborating with a researcher at the CDC in Atlanta to immunize Aotus monkeys so they can measure the immune responses that are elicited. The monkeys are then infected with human malaria parasite *Plasmodium falciparum* to measure the efficacy of the vaccine. If they're successful, the vaccine could be considered a candidate for human trials.

"It would be another component to a cocktail of antigens. There's pretty much a consensus in the field that the ultimate vaccine is going to have to have multiple components against each of the targets and across these development stages," he says.

While the prospects are exciting, Burns says he's learned over his 30-year research career to temper his expectations.

"If you look at the parasites that are circulating in those endemic areas, you'll see that with a lot of what we consider the best vaccine targets, there's a lot of variability from one strain to the next. It can switch amino acids here and there and avoid immune mediated clearance by whatever you may have been inducing by a vaccine effort," he says. "It's not the magic bullet that's going to completely prevent infection the way pre-erythrocytic stage vaccines are designed to do. But it would reduce parasite burdens in these populations and hopefully reduce some of the severe complications of malaria that lead to morbidity and mortality."

Ultimately, Vaidya says, reducing malaria deaths will require increased investments in mosquito vector control, drug development programs, vaccine research and strengthening health systems.

"If a diagnosis is made in time, drugs are available and people can afford to pay for the drugs, we can take care of malaria," Vaidya says. "The problem is that many times all these conditions are not met. That's the reason why we see so many deaths due to malaria."

> *"What we are doing is essentially making drugs that work as cyanide for the malaria parasite without working as cyanide for us."*
>
> *-Akhil Vaidya, professor of Microbiology and Immunology and director of the Center for Molecular Parasitology*

RACE AGAINST

_*Ossubtus xinguense* JÉGU 1992
The eaglebeak pacu, *Ossubtus xinguense*, is restricted to the lower Xingu River where it inhabits rocky rapids and feeds on aquatic vegetation. Rheophilic (current-loving) species like this are particularly sensitive to the effects of dam building. Due to its small range and specific habitat requirements, the eaglebeak pacu is categorized as an endangered species in Brazil.

TIME

Brazil's Xingu River is about to be fundamentally altered by a massive dam project. Researchers from the ***Academy of Natural Sciences of Drexel University*** *are working to inventory the species of that river before the dam goes online—and before the fish that live there are pushed to the brink of extinction.*
_by Tim Hyland / photographs by Mark Henry Sabaj Perez

_MARK HENRY SABAJ PÉREZ
Sabaj Pérez is the Ichthyology collection manager at the Academy of Natural Sciences of Drexel University.

_JOHN LUNDBERG
Lundberg is a professor in the Department of Biodiversity, Earth and Environmental Science (BEES) and the curator and Chaplin Chair of Ichthyology at the Academy.

1 *Semaprochilodus brama* (Valenciennes 1850). Found only in the Xingu and neighboring Tocantins rivers, this is a large migratory herbivore and important food fish locally. 2 *Pseudancistrus* Questionably a new species of *Pseudancistrus*. To answer such questions, taxonomists must make careful comparisons to related species outside of the Xingu watershed. 3 *Scoloplax distolothrix* Schaefer, Weitzman & Britski 1989. Members of the genus *Scoloplax* (spiny dwarf catfishes) are among the smallest freshwater vertebrates in the Neotropics ranging 9-20 mm from snout to base of tail fin. They are commonly found among piles of fallen leaves that litter quiet waters along river banks. 4 *Myleus arnoldi* One of several species of silvery, deep-bodied pacus that feed on and among the Podostemaceae (riverweed) that blankets the rocks of the Xingu rapids.

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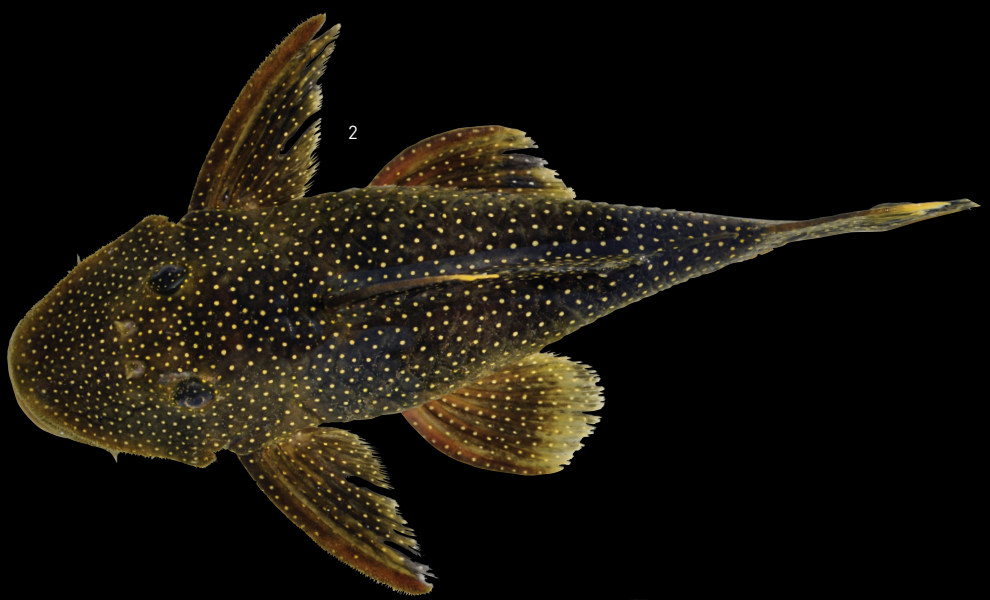

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_THE XINGU RIVER, THE BELO MONTE AND AN UNCERTAIN FUTURE

The Xingu River flows for approximately 1,230 miles through Brazil, starting in the savannas of Mato Grosso, northwest of Brasilia, before emptying into the Amazon River, northeast of Santarém.

The Xingu is the third-largest tributary of the Amazon and drains an area roughly the size of France.

The river basin is home to about 25,000 indigenous people from 18 ethnic groups, according to the environmental group International Rivers.

The Belo Monte Dam project, which is already under construction, will fundamentally alter the flow of the river—and the lands that surround it.

When completed in 2014, the Belo Monte Dam in Pará, Brazil, will become the third-largest hydroelectric dam in the entire world, with a staggering capacity of 11,233 megawatts—more than five times that generated by the iconic Hoover Dam.

Belo Monte is in many ways a symbol of Brazil's rising economic might, and proponents of the $16 billion project say the power created there will go a long way toward helping the growing nation meet its ever-increasing demand for what many perceive as "clean energy."

That much is true. But no dam is built without an environmental price, and with the clock now ticking until the project is completed, a team of researchers from the Academy of Natural Sciences of Drexel University are working to record the stunning biodiversity of the Xingu River before the river's flow is changed forever, before the people who inhabit the Xingu basin are chased from their homes, and before the fish that currently thrive in the river's fast-moving rapids are tested for their very survival—if not globally, then at least locally.

John Lundberg, chair of ichthyology for the Academy, and Mark Henry Sabaj Pérez, an Academy collection manager in ichthyology, along with colleagues at Texas A&M University were recently awarded a three-year, $526,000 grant from the National Science Foundation to inventory and identify the fishes, crustaceans and mollusks of the Xingu, with the specific goal of ensuring science has a full understanding of those species—and the unique habitats that harbor them—before Belo Monte changes the river forever. They will be working with a team of Brazilian researchers on the project, and expect to make their first project-funded trip to the Xingu basin in the fall of 2013.

"The idea here is to be able to compare what existed before the dam and what will become after the dam is built."

But with construction already underway and the dam set to go online in 2014, time is running out.

"We're archiving the diversity of this region and this stretch of river with the expectation that it's going to be changed dramatically once the dam is constructed," says Sabaj Pérez, who made his first trip to the Xingu last year. "The idea here is to be able to compare what existed before the dam and what will become after the dam is built."

Environmental groups have been warning about the potentially crushing impact of the project for decades now, and over the years the project has been halted several times precisely because of those concerns. But by all indications, the project is now moving forward. In fact, there is some

Hydrolycus armatus The genus is derived from the Greek words for "water" and "wolf," the latter inspired by the highly developed pair of dentary canines. Species of *Hydrolycus* are important high-level predators in the Amazon Basin, and use their large canines to stab, pierce and hold prey before swallowing it whole, head first.

_IN FOCUS:

THE BELO MONTE DAM

The Belo Monte Dam project actually includes two dams: The Pimental Dam (233 MW) and the much larger and more powerful Belo Monte Dam (11,000 MW).

The Pimental will block the flow of the Xingu and divert approximately 80 percent of the river toward the dam's main reservoir. The Pimental's spillway will then release the remaing flow back into the Volta Grande.

The Belo Monte will then generate its power from the reservoir created by the Pimental and release the water back into the Xingu.

The cost of the project has been estimated at $16 billion.

It is estimated that the dam could generate more than 11,000MW of energy and create 40,000 jobs during construction.

speculation that the dam may require more disruption to the river's flow than currently planned.

By some estimates, the Belo Monte project—a project that is so large it actually includes two dams and several dikes large enough to be considered dams in their own right—will flood an estimated 500-square km of land, much of which is already deforested. As many as 40,000 people—including some indigenous peoples in the valley—could be driven from their homes.

"There will be huge social implications for the people who live in this region," Lundberg explains. "A lot of this project will impact the land of indigenous people. And these people have a different mindset. They don't consider themselves to be Brazilians. They consider themselves to be the original owners of the place. They don't want the dam. They know it's going to modify things."

Though the exact scope of the dam's impact is currently unknown, what is known is that, no matter what, the river's flow will be changed, and so too will the habitat for hundreds of fish species. That means the Academy project—which will begin with a trip to the Xingu this fall and include at least two more expeditions over the next three years—is of the utmost importance.

The area that will be most impacted by the dam—a huge bend in the Xingu known as the "Volta Grande," or "big bend"—is home to a sprawling network of fast-moving rapids. And it is specifically those rapids that may be responsible for the river's remarkable biodiversity, Lundberg says.

"The river is dominated by fast-moving water that runs over and around a lot of rocks," Lundberg explained. "There are a lot of deep holes under those rocks, and it turns out that, for reasons that we hope to pick apart, the fish assemblage in those areas is very hot in terms of diversity. There are a lot of species that are known to be found only there [in the Xingu], and we believe there are a lot of undescribed species, too."

In fact, Brazilian and American ichthyologists—including Lundberg and Sabaj Pérez—have described 21 new species of fishes from the Xingu in just the past five years. Researchers also know the Xingu's lower reaches are home to at least 26 species that live nowhere else on Earth. Lundberg and Sabaj Pérez say they would expect to identify anywhere from 10 to 20 new species during their three-year project.

Whether or not those species will survive long after the dam is completed, however, remains to be seen. As has been proven elsewhere, dam projects often obliterate native fish populations. Such a scenario can't be ruled out for the Xingu.

"If you look at the Colorado River in the United States, you've got nine big dams along the main stem, and now in many years no fresh water actually reaches Baja, Calif., [where the river terminates]," Lundberg says. "Those dams have had devastating effects on native fishes. Below the lowest dam in the Colorado, there are 15 fishes, and none of them are native."

In other words, the prognosis for the Xingu's native fishes isn't good. But at the very least, says Sabaj Pérez, the Academy project will make sure all of the Xingu's fishes are put on the record, allowing scientists to study them for years and decades to come and help to bring greater understanding of the unique Xingu ecosystem.

"Those dams have had devastating effects on native fishes. Below the lowest dam in the Colorado, there are 15 fishes, and none of them are native."

Their work may also help shape the debate about future dam projects—and indeed, Brazil especially is considering a slew of new dam projects.

"Perhaps it will show us ways of minimizing the impact of dam building on natural river systems," says Sabaj Pérez. "If we see a tremendous impact, such as the fauna of the river completely changes or some fish are completely lost, that could inform arguments against the construction of other dams. Or at the very least, if a dam needs to be built, maybe we could talk about putting it in an area that would not impact a very unique assemblage of fishes."

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1 *Archolaemus janeae* Vari, de Santana & Wosiacki 2012. A species of electric knifefish known only from the Xingu River and upper portions of the neighboring Tapajós River. Such knifefish are nocturnal and remain well hidden during the day in rocky crevices. 2 *Megalodoras uranoscopus* (Eigenmann & Eigenmann 1888). This may, in fact, be a different, but related species of thorny catfish that is restricted to the Xingu and Tocantins Rivers. 3 *Ancistrus ranunculus* Muller, Rapp Py-Daniel & Zuanon 1994. Adult male Medusa pleco described from the Xingu River by Lúcia Rapp Py-Daniel and Jansen Zuanon, Brazilian senior collaborators on the NSF-funded Xingu project. 4 A new species of pacu in the genus *Tometes*, endemic to the Xingu. Large males like this are best caught by spear (notice the wound) when they move into swift shallow rapids to feed on aquatic macrophytes.

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1 *Potamotrygon leopoldi* (Castex & Castello 1970) Juvenile Xingu River ray endemic to the Rio Xingu. The attractive color pattern makes it a popular species in the ornamental fish trade. It prefers rocky bottoms of large clear water rivers where it feeds on snails and crabs. Its limited distribution renders it vulnerable to habitat degradation. 2 *Potamotrygon orbignyi* (Castelnau 1855) Juvenile Smooth back river stingray. Common throughout the Amazon where it is often found at night foraging in shallow waters off large, sandy beaches.

_ONLINE
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MALACOLOGY

_TYPE SPECIMENS, IMMORTALIZED

*The malacology collection at the **Academy of Natural Sciences of Drexel University** is one of the largest in the world, numbering more than 8 million specimens, with examples of roughly half the known living species of mollusk.*

As the oldest collection of its kind in North America, the collection of mollusk at the Academy of Natural Sciences of Drexel University is rich in type specimens, which are of great scientific importance because they are the original specimens upon which a new species is based. The collection has marine, terrestrial and freshwater specimens from all parts of the world, with greatest strength in North America, Asia and Oceania.

The type specimens in the malacology collection are accessible through visits to the Academy, something not always feasible for researchers overseas. But a recent grant from the National Science Foundation is helping Academy scientists share this collection with researchers around the world. The three-year grant is funding production of digital images of thousands of type specimens. The specimens are being imaged with regular photographic equipment and smaller ones also with a scanning electron microscope, or SEM.

"There are about 12,000 specimens, and with several views of each specimen, plus pictures of the labels, we'll end up with something like 60,000 images online," says Gary Rosenberg, head of the Academy's Malacology Department and principal investigator of the project.

The SEM allows a viewer to see features of a specimen that cannot be captured through traditional photography. This is especially helpful since many of the type specimens measure less than 3 millimeters.

"We're also upgrading our database information and linking each type specimen to the original bibliography where the descriptions were published," he added. One full-time project manager and two Drexel co-op students will each need to work at a rate of one type sample per hour to complete the imaging and database upgrade in the three-year period. It's a huge amount of work, but the team is determined.

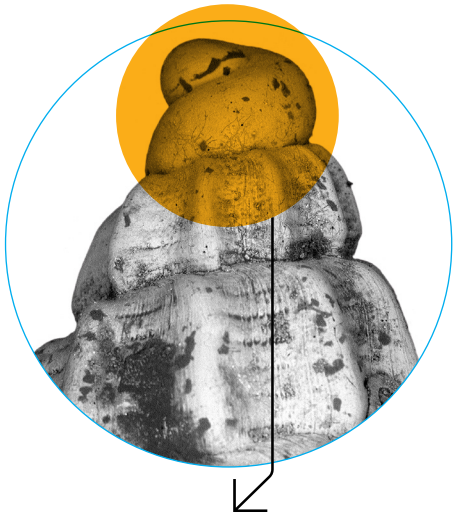
"Type specimens are the standard of reference to be sure you've identified a species correctly," Rosenberg says. "By making pictures of our types available online, we're giving scientists all over the world access to information. And since we have material from all over the world, we're democratizing science."

Placing images of these type specimens online will not just increase the research value of the Academy's collection but will also help scientists determine the conservation status of particular mollusk species, which is urgently needed throughout the world.

SMALL _SPECIMENS
The type specimen of a new species in the marine snail genus *Pusia*, soon to be described. A U.S. penny is shown for scale.

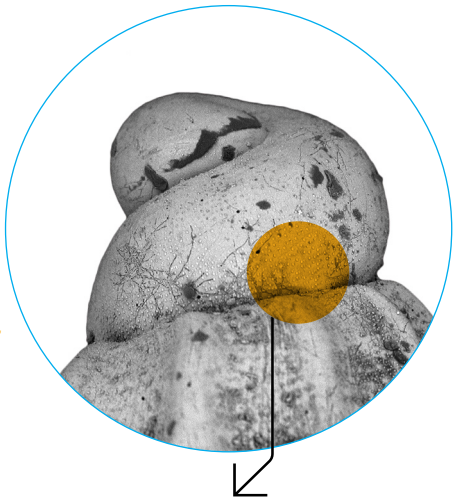
CLOSE_UP

The Scanning Electron Microscope reveals finer detail than optical photography, illustrating more fully the characteristics of the species.



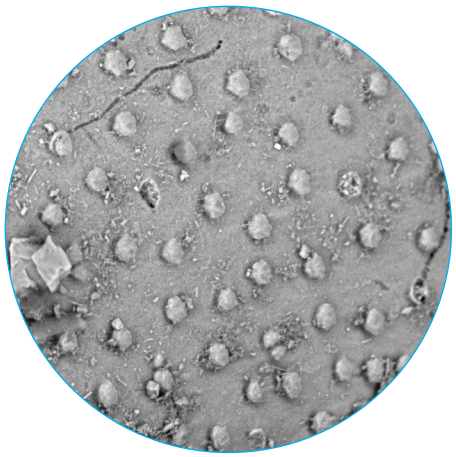
200X

At 200x magnification, the fine sculpture of the shell is more clearly visible.



400X

At 400x magnification, the sculpture of the first part of the shell becomes visible.



4000X

At 4,000x magnification, this "hidden" sculpture of small triangular scales is clearly visible.

BIOLOGY

_PRESERVATION STARTS WITH ALGAE

_RICHARD McCOURT
McCourt is a professor in the Department of Biodiversity, Earth and Environmental Science and associate curator of botany at the Academy.

Jillian Adair has a strong interest in the restoration and preservation of the natural ecosystems in the world. It's an effort, she says, that starts at the lowest rung of the natural world: algae.

"Plants and green algae represent the base of the food chain in many ecosystems. I believe that studying botany—and more specifically phycology (the study of algae)—will help me learn how to understand and eventually repair ecosystems starting from the base of the food chain and working up," Adair says.

Adair is pursuing undergraduate and graduate degrees in environmental science. She began working in the Botany Department with Richard McCourt, a professor in the Department of Biodiversity, Earth and Environmental Science (BEES) and associate curator of botany, and John Hall, a postdoctoral research associate, as a freshman. Last year, she presented her research at a national meeting of the Phycological Society of America. Her research was supported by a National Science Foundation grant called "Research Experiences for Undergraduates."

"Green algae are evolutionarily fascinating—some are closely related to land plants—and we continue to study this aspect of their evolutionary history in our lab," explains Hall. "We do not know how many species exist. Many new species are discovered every year. We do not understand how most species are related to each other or how their unusual life histories and structural characteristics have evolved."

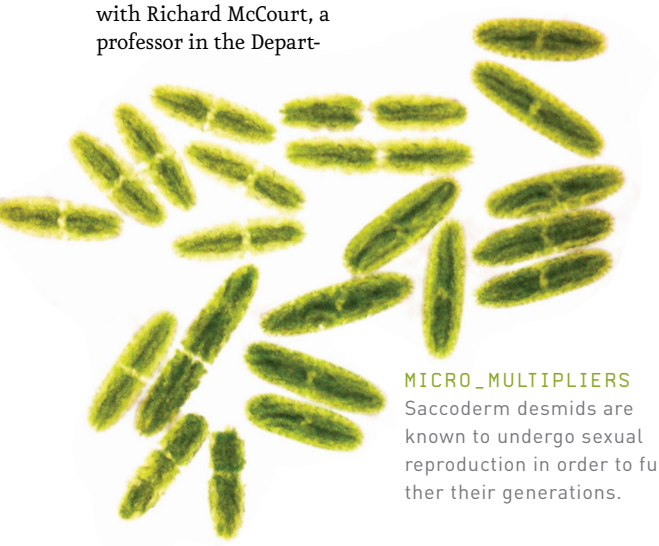
Their research has zeroed in on saccoderm desmids, a group of green algae that falls under the class Zygnematophyceae, alias "conjugating green algae." Saccoderm desmids are known to undergo sexual reproduction in order to further their generations. During conjugation, two cells line up and a tube forms between them. Their cellular components migrate to the middle of the tube and merge to form a zygospore, which eventually germinates and grows into a green algal cell.

Although the relationship between saccoderm desmids and land plants are not conclusive, it is believed that the Zygnematophyceae may be the class of algae most closely related to land plants, Adair says. This means that saccoderm desmids and other conjugating green algae may share a more recent common ancestor with land plants than to most other green algae.

To explore this possibility, Adair and Hall have cultured green algae. By doing so, they grow a green algal strain in a defined medium under controlled conditions. Cells are cultured in order to get enough tissue material for DNA sequencing. Through this process, as well as the commonly used method of DNA extraction, they were able to collect and compare the DNA sequences of many green algal strains with others.

Specifically, Adair sequenced the DNA of many strains that fall under a genus of saccoderm desmids, called Cylindrocystis.

"I discovered that this genus is polyphyletic [character states that have converged or reverted to appear to be the same but have not been inherited from a common ancestor]," Adair says. "Therefore, more research needs to be done in order to properly label the two separate clades [groups consisting of an ancestor and all of its descendants, a single branch on the tree of life]."



MICRO_MULTIPLIERS
Saccoderm desmids are known to undergo sexual reproduction in order to further their generations.

ENVIRONMENTAL POLICY

_MONITORING THE DELAWARE

The Academy of Natural Sciences of Drexel University has been performing watershed and aquatic science research since the 1940s. For the past year, Academy scientists have provided scientific guidance to the William Penn Foundation as it began plans to focus its environmental funding on watershed protection and restoration. The foundation recently awarded a one-year grant award of $880,000 that will take the Academy's advisory role to a new level.

The grant supports collaboration between the Academy and the foundation to guide the scientific measurement and evaluation of conservation efforts across a wide region—and to ensure the foundation's other grants are coordinated with one another and with the larger context of regional watershed conservation activities. The Academy's guidance will therefore influence the activities of other organizations working across the Delaware Valley region to protect and restore water quality.

"Our collaboration with the William Penn Foundation and the other partners in this project has provided the Academy and Drexel with an incredible opportunity to apply high quality science to a key area of public interest," says Roland Wall, senior director of environmental initiatives at the Academy and project leader for the grant. "Water is central to every facet of nature and of society; this work will help ensure the health and safety of water and watersheds across the Delaware Basin."

The Academy's role in the coming year will be to take baseline measurements of environmental conditions in designated sites across the Delaware basin. As other organizations work with the foundation to secure funding for their own conservation programs at specific sites, the Academy will serve in an outreach and mentoring role to guide the development of these projects. Academy scientists will also coordinate a process to identify research questions that might emerge from the funded projects. For example, some research questions might compare the effectiveness of different restoration methods.

LEADERS_IN_THE_FIELD
The Academy's watershed research uses field and laboratory studies to analyze and simulate the functioning of aquatic systems, integrating mapping with hydrologic, bioenergetic, ecological and other methods of measurement and analysis at multiple spatial scales.

Ultimately, the Academy's scientific expertise and measurements will guide coordinated, region-wide work to address major environmental stressors in the watershed, demonstrate the effectiveness of interventions and ensure these efforts can be replicated at other sites.

_JOINING THE SWARM

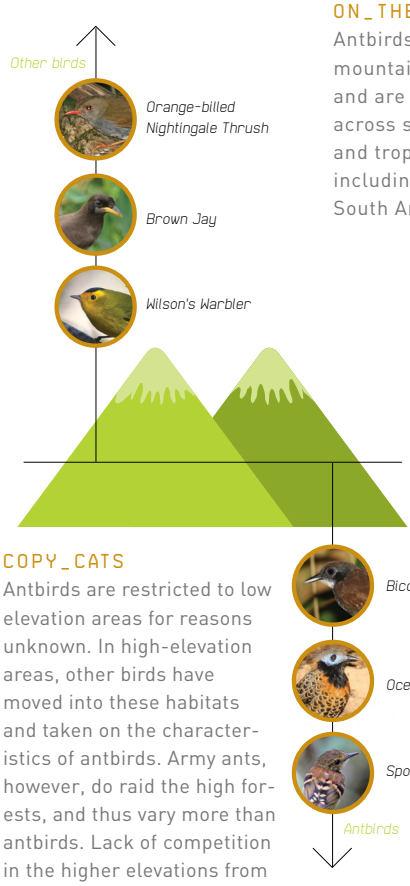
Sean O'Donnell's research into army ants has opened up a new understanding of a peculiar South American bird species.

Since 2005, Sean O'Donnell, associate department head of the Department of Biodiversity, Earth and Environmental Science (BEES), has been researching army ants and their relationship to antbirds. In fact, he has shared his expertise on documentaries about army ants, the most recent being "Wild Things with Dominic Monaghan." But his research on ants has helped him better understand another set of species: birds.

"One thing you really can't help but notice when following army ant colonies around is an amazing array of birds that come down and troop along with the army ants as they sweep through the forest. We started realizing that the set of bird species doing this in the mountain forests was different than the bird species doing it in the lowlands. That got us thinking about how interesting it might be to study bird interactions with army ants in the mountain forests," O'Donnell explains.

Missing from the mountain forests are a family of birds called antbirds. Antbirds are indigenous across subtropical and tropical areas, including Central and South America.

When army ants are swarming through the forest, they scare off many small animals. The birds swoop in to capture them. Some antbirds get little or none of their food from anywhere else; they rely completely on following army ant colonies. They move through the forests and memorize the ants' locations, and out-compete other birds.



ON_THE_MAP

Antbirds reside in mountain forests and are indigenous across sub-tropical and tropical areas, including Central and South America.

COPY_CATS

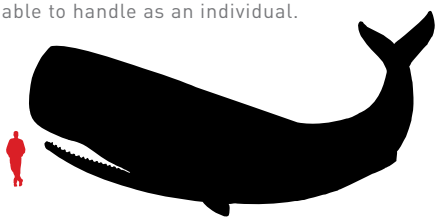
Antbirds are restricted to low elevation areas for reasons unknown. In high-elevation areas, other birds have moved into these habitats and taken on the characteristics of antbirds. Army ants, however, do raid the high forests, and thus vary more than antbirds. Lack of competition in the higher elevations from true antbirds may be the reason other birds move in.

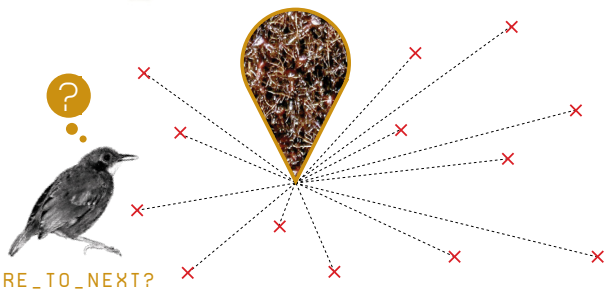
BIG_EATERS

Army ants are carnivorous predators that kill animals much larger than themselves. The prey includes scorpions, cockroaches, wasps, bees and other ants.

TEAM_EFFORT

If you think of the size of a big scorpion compared to a tiny army ant worker, the size differential is comparable to the difference between a human and a whale. By acting in a group, the army ants have allowed themselves to attack and exploit things that they wouldn't be able to handle as an individual.





WHERE_TO_NEXT?

The army ant raids provide a bonanza of food to birds that come in and follow them. The problem for the antbirds is the army ant colonies are mobile; they don't raid in the same direction any two days in a row. They move out from a central location, raiding in different directions.

Army Ant: Alex Wild

MYRMECOLOGY

_THE SCIENCE OF STICKINESS

The Drexel study on Ponera, a genus of ants that possesses ***"sticky appendages,"*** *could provide insight on potential applications outside of the insect kingdom.*

When the Rolling Stones released its classic album "Sticky Fingers" in 1971 with a provocative Andy Warhol-designed cover, it garnered a fair amount of controversy in the United States.

The album has become something of an inspiration for a team of scientists in

_KAITLIN BAUDIER
Baudier is a PhD student in the Department of Biodiversity, Earth and Environmental Science (BEES).

the Department of Biodiversity, Earth and Environmental Science (BEES). Their new research into the evolution, workings and purpose of "viscous fingers" or "sticky appendages" on a primitive but understudied ant genus may not shock the world. But these particular ants have some very sticky fingers, and there may be potential applications that could attract much wider interest.

Dig up a nest of ponerine ants, and you're likely to see larvae defying gravity, clinging to the nest chamber walls. Prying them off takes considerable effort, says BEES graduate student Kaitlin Baudier. Sean O'Donnell, Baudier's adviser and the associate department head for BEES, encouraged her to investigate the evolution and mechanism of the tiny "sticky tubercles" on the dorsal side of the larvae that facilitate the connection.

Baudier has long been fascinated by ants. As a PhD candidate, part of the draw of coming to Drexel after completing her undergraduate degree at Louisiana State University was the chance to work with O'Donnell, a recognized leader in the field of social insects.

"I got to look at all the specimens and got to know their species, so to speak. It was great because I got to look at a wide diverse sample of ants and find a lot of interesting topics that were pretty fascinating," she says.

Using ponerine ant specimens that O'Donnell had brought back from a previous expedition to Costa Rica, Baudier first looked to determine whether the shape and function of the sticky tubercles had changed over time. Her literature review turned up hand-drawn illustrations and descriptions of the tubercles from similar ants made by a Japanese scientist in 1927.

"With modern technology, it's interesting to take another look at them," she says. "We found a few specimens that have an interesting-shaped pad that are a little different from other ones that are often talked about in literature."

Baudier and O'Donnell partnered with Marjorie Austero and Caroline Schauer of the Materials Engineering Department to study the exterior surface of the sticky tubercles using scanning electron microscope technology. They used a parsimony analysis of the ponerine ant subfamily to reconstruct ancestral states.

What they discovered is that the ancestors of ponerine ants likely did not have sticky tubercles, and that they've evolved at least four times within subfamily ponerinae.

Furthermore, the imaging and histological tests of the tubercles' anatomy revealed the surface of the tubercles to be smooth and non-porous. So if the ant larvae are producing a sticky compound through a chemical process, it's not being emitted through the surface pads.

NEW_APPLICATIONS
Additional research is needed to quantify just how sticky the ants' sticky substance is, as well as to determine if there are any practical applications for its use in the human world.

PUBLIC HEALTH

_BEETLES, TREES & HUMAN HEALTH

Infestations of ***emerald ash borer beetles*** *could be uniquely tied to cardio vascular and lower respiratory diseases in humans.*

ASH_BORER_BEETLE
The emerald ash borer, *Agrilus planipennis*, was discovered in southeastern Michigan in 2002.

The loss of 100 million trees recently in the eastern and midwestern United States was an unprecedented opportunity to study the impact of a major change in the natural environment on human health for researchers at the U.S Forest Service, Yvonne Michael, a professor of epidemiology and biostatistics, and their colleagues.

In an analysis of 18 years of data from 1,296 counties in 15 states, researchers found that Americans living in areas infested by the emerald ash borer, a beetle that kills ash trees, suffered from an additional 15,000 deaths from cardiovascular disease and 6,000 more deaths from lower respiratory disease when

compared to uninfected areas. The borer attacks all 22 species of North American ash and kills virtually all the trees it infests.

The researchers analyzed demographic, human mortality and forest health data at the county level between 1990 and 2007. The findings, which hold true after accounting for the influence of demographic differences, such as income, race and education, were published in the *American Journal of Preventive Medicine*.

"The devastation from emerald ash borer on ash trees provided a unique natural experiment," Michael says. "Existing research is limited by primarily cross-sectional designs and subjective measures of environment."

Although the study shows the association between loss of trees and human mortality from cardiovascular and lower respiratory disease, the study cannot prove a causal link. The biological mechanism of action linking trees to mortality is not known but may include physical activity, social capital and/or improved air quality.

The study was conducted by the Forest Service's Geoffrey Donovan and Michael in collaboration with David Butry, with the National Institute of Standards and Technology; and Jeffrey Prestemon, Andrew Liebhold, Demetrios Gatziolis and Megan Mao with the Forest Service's Southern, Northern and Pacific Northwest Research Stations.

Michael's research explores social and physical environmental determinants of health. The NIH and other organizations fund her research.

MOBILITIES

_ON THE MOVE

_MIMI SHELLER
Sheller is the director of the Center for Mobilities Research and Policy and a professor of sociology.

Joseph is a truck driver from Fonds-Parisien, Haiti, who has nine children. His family has lived by Lake Azuei for generations.

In the past 10 years, the lake has risen more than 10 meters and has doubled in size, from 155 square kilometers in 2004 to 354 square kilometers today. As the waters rose and began to spill over the banks, Joseph's land has gradually disappeared underwater, taking with it his home and those of his extended family.

"[The floodwaters] have diminished our ability to work because we lost nearly everything we invested in this land," Joseph says in an interview translated from his native language, Haitian Creole. "Life has become much worse because we have to find a way to build other houses."

Three kilometers away, in the Dominican Republic, Lake Enriquillo is also rising with no signs of stopping, and has already engulfed farmland, houses and roads.

In an effort to understand the toll that the surging waters have taken, Mimi Sheller, director of the Center for Mobilities Research and Policy in the College of Arts and Sciences, joined a team studying the imperiled lakes on the border between the two countries.

"Knowing what is causing the lakes to rise—whether it's a climate-related or geological phenomenon—will help officials in the Dominican Republic and Haiti develop effective mitigation strategies," says Sheller.

The project, titled, "Understanding Sudden Hydro-Climatic Changes and Exploring Sustainable Solutions in the Enriquo Water Basin (Southwest Hispaniola)," received nearly $200,000 in funding from the National Science Foundation's Rapid Response Research grant program, designed specifically to respond to unusual circumstances that need to be addressed with some urgency.

FLOODED_LAND
The team plans to return to areas such as Lake Enriquillo to present their findings to various organizations.

CLIMATE CHANGE

_MONGOLIAN PERSPECTIVE

For the nomadic herders of Mongolia, there is no question as to whether ***global warming*** *is occurring. They know it is–and see the impacts every single day.*

Clyde Goulden, director of the Asia Center at the Academy of Natural Sciences of Drexel University, has spent two decades traveling to the mountains of northern Mongolia in search of one thing in particular: climate change.

He's seen significant changes resulting from data collected through long-term environmental surveys and monitoring. But another kind of survey, which began in 2009, has shed a different light on the changes. Goulden has interviewed firsthand the Mongolian nomadic herders who survive off the land.

"The changes they are seeing are substantial. They're very concerned, and most herders are very pessimistic about the future."

–Clyde Goulden, director of the Asia Center at the Academy

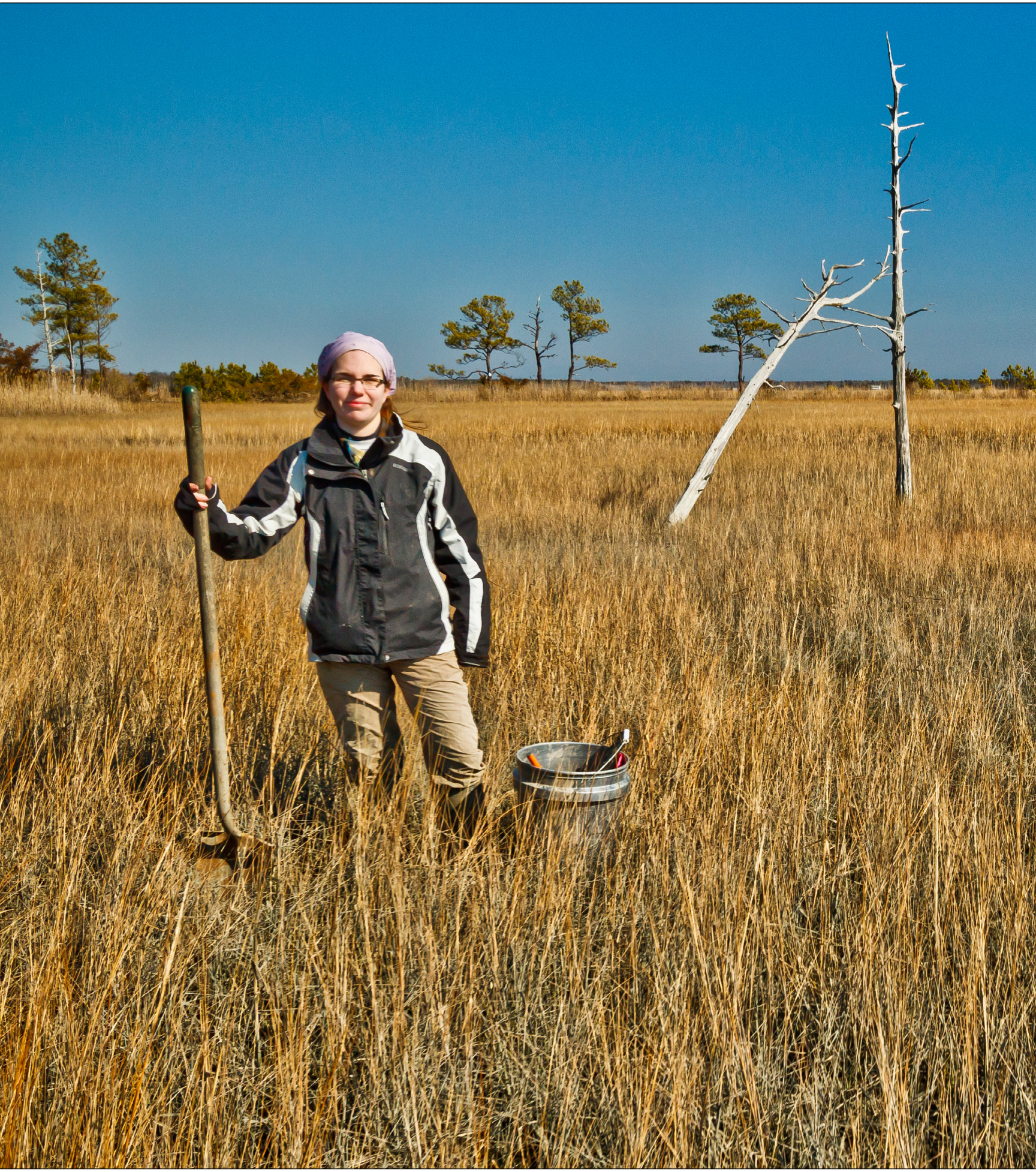
The survey in Mongolia began for Goulden and his colleagues in 1994. At that time, the country was a particularly interesting study site with its huge land mass, very small human population and fairly strict political conditions that prevented a lot of human interference. In the 1990s, it was one of the few places in the world that had study sites that were almost completely pristine. Since the fall of communism, the economical and political changes have allowed greater impacts on the environment. Goulden's arrival in the '90s couldn't have come at a better time.

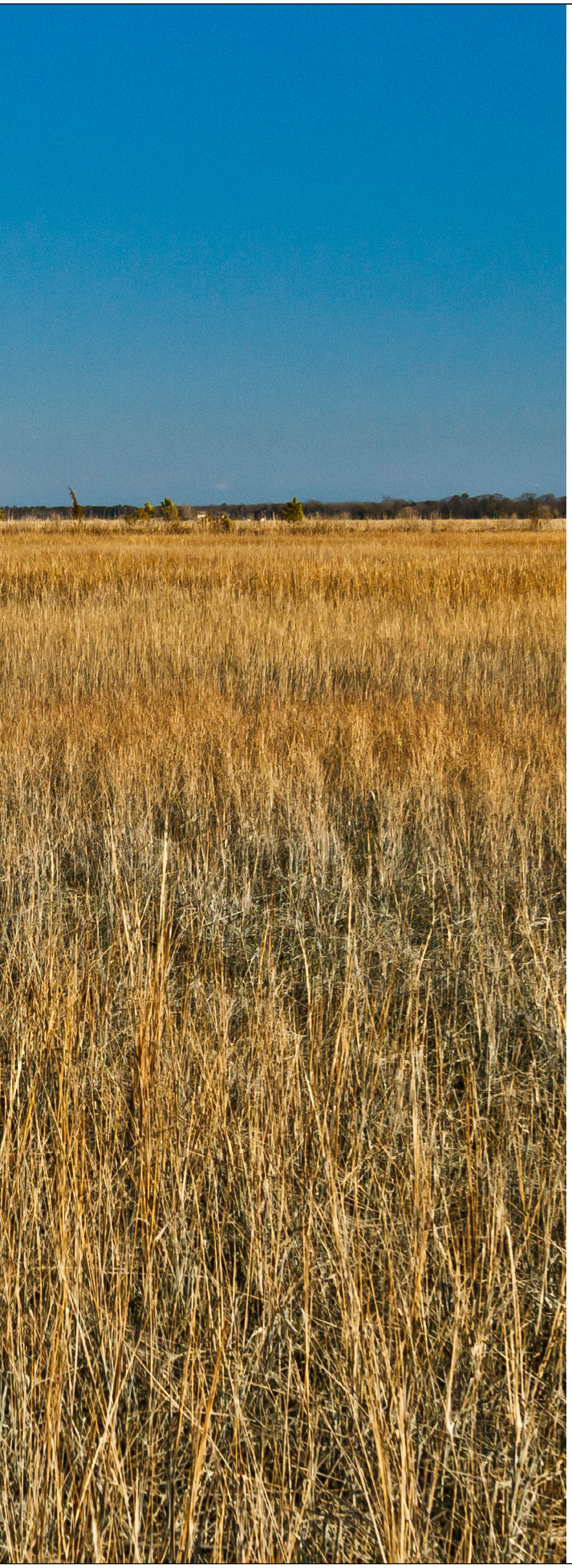
It was then that Goulden witnessed near-perfection in the form of a pristine and ancient lake in the northernmost extension of Mongolia. Roughly 100 miles long and 30 miles wide, Lake Hovsgol is one of the purest freshwater bodies in the world.

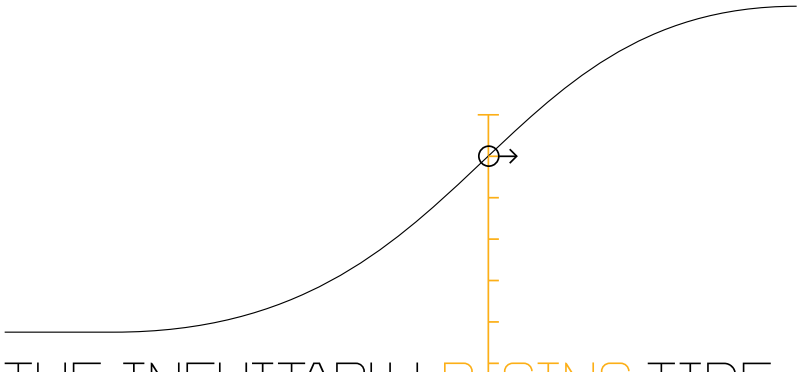
"I was very anxious to visit," Goulden recalls. "I wanted to learn more about the lake from what had been studied previously by the Russians and Mongolians. Not much had been published in English, so I wanted to learn what was there and the potential for future study."

Over the next 18 years, Goulden and his colleagues traveled to Mongolia once (sometimes twice) a year on grant-funded assignments for studies in biodiversity assessment, environmental monitoring, land-use management, ecotourism development, social anthropology and capacity building for young scientists.

From 2002 until 2006, Goulden served as the international consultant for a Global Environment Fund/World Bank-funded, capacity-building project to train young Mongolian researchers in environmental studies, including meteorology, biogeochemistry and ecology of major plant and animal populations.







THE INEVITABLY RISING TIDE

Sea level rise is a global problem with local consequences. Drexel's ***Anna Jaworski*** *is working to help officials along the Delaware Bay make smart decisions about coastal development.* _by Tim Hyland / photographs by Tommy Leonardi

PERFECT_FIT
Jakes Landing is an area traditionally frequented by fishermen and birders, yet it is uniquely fit for studying sea level rise and salt marsh loss rates.

It's a cold, blustery February day on the New Jersey coast, and Anna Jaworski is wading her way through a salt marsh that seems to go on forever. From where she stands, about 100 yards from the modest parking lot at the Jakes Landing-Dennis Creek Wildlife Management Area, one can look out and see almost nothing but marsh grass and dead trees in one direction, a thick coastal forest in the other and, in the distance, the waters of the creek itself.

In a lot of ways, the place feels like the middle of absolutely nowhere, which is hardly surprising: It basically is the middle of absolutely nowhere. But according to Jaworski, that desolate salt marsh and the forest that borders it may hold the keys to helping scientists understand just how much rising sea levels have impacted the Delaware Bay over the past few decades—and, more importantly, how much more land will be gobbled up by the rising waters in years to come.

Jaworski, a graduate student in the Department of Biodiversity, Earth and Environmental Science (BEES), has been working for two years to piece together a sort of historical record of sea level rise and salt marsh loss along the Delaware Bay, with the ultimate aim of gaining a fuller understanding of how sea level rise—which is a truly global issue—has manifested itself locally. The idea is to help officials in Delaware and New Jersey prepare for the widespread changes—and enormous land loss—that are bound to arrive in years to come, as seal levels rise at an ever faster rate.

Indeed, some scientists have projected that sea levels could rise by a staggering 19 inches by the year 2050. While that number sounds alarming—and it most certainly is, according to Jaworski—her aim is to put together a more clear and more accurate prediction for what will happen specifically along the Delaware Bay.

CRITICAL_MARSHES
Salt marshes, including those of the Delaware Estuary, are some of the most productive ecosystems in the world, providing critical habitat for numerous species.

"We are seeing a substantial increase in sea level rise rates," Jaworski says. "That's starting to worry us. Sea levels have always changed, but this is very rapid. What we're interested in with this project is the local relative sea level rise, so we know what will happen on the local level, so we can help people respond."

And if one thing is almost certain, it seems, it's this: Those people will have to respond.

Or else.

"When Hurricane Sandy hit, the storm surged in some places about four meters, and we saw the damage that was done," explains Ken Lacovara, an associate professor in the BEES Department. "Well, some people are talking about that kind of [sea level] being the reality on a nice, normal day in the year 2100."

The doomsday scenarios are certainly out there: Entire coastal cities underwater, habitats destroyed, species pushed to the brink of extinction. One can certainly debate the causes of these changes, Lacovara says, but what one can't deny is that the changes *are* happening, and will continue happening. Coastal communities worldwide will be challenged by these changes, and will need to adapt.

The only question is, "How?" and, "How much?"

That's where Jaworski's work comes in. And it is dirty work, indeed.

To compile the data she needs for her project, which was funded in part through a grant from the DuPont Foundation, Jaworski needs to make regular trips down to places like Jakes Landing, where she spends hours engaged in one of two activities: Hacking her way through the woods to gather core samples from trees in the nearby forest, or sloshing her way through the salt marsh to extract peat cores from the marsh floor. Each sample holds different clues to the climate, past and present, of the area.

"With all of these dead trees, what we want to figure out is when the tree died," she explains. "That's important because the year of death directly corresponds to when it was inundated with water."

Specifically, Jaworski targets eastern red cedars, a type of tree that just so happens to be incredibly rot-resistant. An eastern red cedar inundated with water might die rather quickly, but it can remain standing for decades afterward. And indeed, the marshes around Jakes Landing are peppered with dead cedars; by coring both those trees and living ones nearby, Jaworski is able to not only understand how far and how fast the water has risen, but also better understand how the climate has impacted the area in other ways.

"Those tree rings are basically the recording of the climate of that entire year," she says. "The rings change in size based on any number of conditions—if you have better conditions, you have better growth. One of the reasons we're particularly interested in this is that we're seeing more storms, unfortunately. Hurricane Sandy was a horrible event, but it really woke people up to the problem. The question isn't whether we can rebuild. It's whether we rebuild at all. Or, at least, how close [to the coast] do we let people rebuild?"

Such questions have been asked with greater frequency recently thanks to a series of natural disasters that have made clear the risks of building large cities along flood-prone areas. Hurricane Katrina almost completely devastated New Orleans in 2005, of course, but it was Hurricane Sandy—a storm that struck the Northeast with devastating force—that may have really put the issue on the map. Sandy not only left millions of people in the Northeast without power, but also left some coastal communities—including some in New York City—completely under water. In that storm's wake, politicians in storm-stuck areas like Hoboken, N.J., were left to consider such radical ideas as sea walls to help prevent a recurrence in future storms.

Along the Delaware Bay, and in sparsely populated areas such as those surrounding Jakes Landing, the impact of Sandy and other storms hasn't been quite as dramatic. But as Jaworski has already proved, huge swaths of land have been swallowed up there anyway—it's just taken a few decades for it to happen.

"All of the stuff that scientists have been warning everyone about since the 1980s related to climate change and sea level rise—well, it's happening," Lacovara says. "You can walk about and see a drowned forest and see that it's happening. This stuff is real. I get frustrated when I see people in the media debating whether it's happening. I mean, sea levels could not possibly have risen if the world was not getting warmer. We know for 100 percent certain that sea levels are rising. Therefore, we know the Earth is warming."

With that debate settled, then, the next steps are obvious: Planning for a wetter, warmer future.

That's where researchers like Jaworski come in, Lacovara says. She, and others like her, are making a global issue understandable on a local level.

"Scientists don't always do a great job of communicating to the public," Jaworski says. "And that's why a big part of this project is about outreach. It's about getting the information out to the people who live there."

"Things *are* changing," she adds. "We can't stop them. We either have to adapt to them, or that's it. If we don't think ahead, we're just going to have more problems."

BAY_SAMPLE
Using a peat auger, Jaworski takes a sample of peat, partially carbonized vegetable tissue formed by partial decomposition in water of various plants.

COUNTING_RINGS
Jaworski holds a sample mount containing several tree core specimens. Each core specimen will be cut in half and studied to determine the age of each tree and the year it dies.

_ONLINE
For more images of Jaworski's research, visit **EXELmagazine.org**

_by Tim Hyland

_FACE VALUE

The secretive, little-understood drill monkey has thrived for centuries on the African island of Bioko. But with hunting pressures now pushing the species to the brink, Drexel researchers are fighting back—and working to convince islanders that the monkeys, and the biodiversity they represent, are worth a great deal more than the $300 they fetch at market.

THREE-HUNDRED DOLLARS.

BIOKO_DRILL_MONKEY
Though they look very similar to baboons, Bioko drill monkeys, *Mandrillus leucophaeus poensis*, are more closely related to mandrills.

That's the going rate for a dead drill monkey on the island of Bioko these days.

Three-hundred dollars.

It's a nice chunk of change on Bioko, a stunningly beautiful but deeply isolated and impoverished island located 20 miles off the coast of Cameroon, on the West Coast of Africa, in the nation of Equatorial Guinea. Indeed, $300 is more than most islanders will make in a month, and a hefty portion of what many will make in a year.

Three-hundred dollars.

For that, a discerning buyer—mostly, the folks who work for the government, the ones who've escaped the forests and work in air-conditioned offices and are perceived to have "made it"—can cook up the local delicacy that is drill monkey, a primate species that has lived on the island for centuries, but suddenly finds itself pushed to the brink, and for just one reason: hunting.

Three-hundred dollars.

This, it seems, is the price point at which the islanders of Bioko—or, at least, some of them—are willing to sell the future of not only the drill monkey, or the other six monkey species on the island, but the very environmental stability of the island itself—a place that, despite its isolation and despite the political instability that so dominates Equatorial Guinea, holds vast potential, not only as an important venue for scientific research, but also as a future destination in the fast-growing eco-tourism market.

Three-hundred dollars.

It's a symbolic sum, and a powerful sum, and on Bioko, a pretty large sum. It's also what a small group of Drexel researchers are currently waging war against. But the clock is ticking, and right now, the money is winning.

AN ACCIDENTAL DOCUMENTARIAN

So far as drill-monkey documentarians go, Shaya Honarvar is certainly not the norm.

While it is true that Honarvar has found herself engaged in some pretty serious drill monkey research on Bioko over the past few years, and while it is also true that she recently produced a documentary, which aired in December 2012 on African television about the perilous state of the Bioko drills, the simple truth of the matter is that Honarvar, a Drexel research associate in the Department of Biology, is not an expert in drill monkeys at all. Or even monkeys in general. Rather, Honarvar is a sea-turtle specialist.

It was her work studying the similarly imperiled olive ridley sea turtles of the Pacific—like the monkeys, the turtles are being threatened by human pressures, rather than environmental ones—that sent her to the island in the first place. She made her first trip to Bioko in 2007, when she was still a student at Drexel, and has returned every year since.

But it wasn't until 2010 that she even thought about the monkeys that now occupy so much of her time. And the only reason she got interested in them, it seems, was boredom.

"The turtle work is mostly done during the night, and during the day we didn't have a lot to do," explains Honarvar, who earned her PhD from Drexel and previously studied the olive ridley sea turtles of Central America. "You're there out in the forest, there is nothing else to do, so you're always looking for other things to distract you. That's basically how it started."

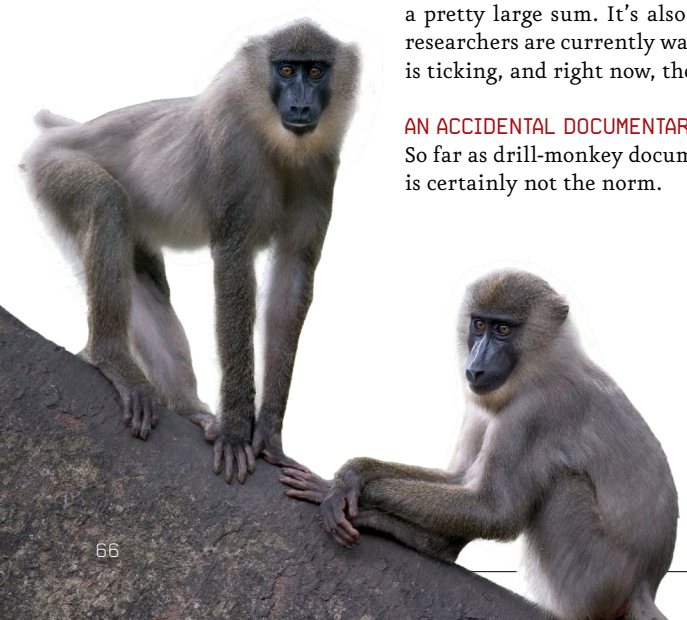
Though they had spent the entirety of their early years on the island focused on the turtles, Honarvar and her team—including volunteer Justin Jay, a biologist with the South Carolina Department of Natural Resources who was the first to propose the drill project—had always been aware of the monkeys. It would have been nearly impossible not to be aware of them.

The monkeys are indeed extremely private (as the filmmakers would later find out) but because they are so densely populated on Bioko—populations here are three times what can be found elsewhere in the world—the researchers saw them often. While the monkeys were seen, they most certainly weren't understood. By anybody.

What did the drills actually do out there in the forest? How did they live? What did they eat? Just how badly had the hunting pressure damaged the populations as a whole?

These were questions to which nobody seemed to know the answers.

"When we started out, it was really just us basically walking around the forest trying to find these animals," Honarvar says. "I had seen them, but only when they were running away from us. It was almost a case of us just being curious about them. How close could we get to these animals? It started out as a game and then just became more serious."



opposite: Tim Laman, ILPC RAVE

TREASURE_ISLAND
Thanks to the 35 feet of rain that falls on the island each year, Bioko is home to a lush rainforest and incredibly diverse wildlife—a scientific gold mine.

And as the work became more serious, so did Honarvar's and Jay's investment in it. They started to see the little side project as much more than that; rather than something to pass the time, they saw the opportunity to make a real contribution—scientifically and culturally—not only to the drills, but to the island as well. They also learned fairly quickly that the drills weren't going to make the work easy.

Indeed, even as the team found that shockingly little behavioral research had actually been done on the drills, they were also learning precisely why the dearth of research existed. The monkeys, skittish around humans because of the unrelenting hunting pressures, were not easy to get near. In fact, Honarvar and her team found it nearly impossible.

"The goal was to have pictures and videos of them because we know that nobody had done that with drills in the wild," she says. "So we started taking our camera with us. But we realized we were never going to be able to take pictures. They hear the [click] of the camera and they're gone."

In a sense, the monkeys' fear of humans proved to be a blessing, as the problems with the click cameras ultimately drove Honarvar to video—and by extension, to the documentary. The video cameras were comparatively much quieter than the still cameras, and so long as the researchers sufficiently hid themselves—which they eventually did, thanks to a series of elaborately designed blinds that they set up all throughout the forest—they found they could, in fact, get close enough to the monkeys to get the footage they needed.

With it, they would be able to start collecting data that scientists had been seeking for years.

Unwittingly, they also took their first steps toward producing a film that could eventually change the way the islanders look at the monkeys—and the island as a whole.

A FOCUS ON BIODIVERSITY

Gail Hearn says she wasn't all that interested in drill monkeys at the start.

Long before Hearn ever set foot on Bioko, long before she established the Bioko Biodiversity Protection Program and long before she moved the entire BBPP project over to Drexel in 2007, she was a professor of biology at nearby Arcadia University.

As part of her work at Arcadia, Hearn and her students became aware of an ambitious project to establish a drill colony at the Philadelphia Zoo. It was an effort that proved to be unsuccessful—and Hearn's students wanted to find out why. Somewhat reluctantly, she agreed to help find out.

"Gradually it was decided that we would go over to look for drills in Africa—to try get a feel for how they lived and why the program at the zoo wasn't working," Hearn recalls. "We went to Cameroon in West Africa, and we saw leaves that had been moved by the drills, but never saw the drills themselves. That wasn't very satisfying. But then we heard in 1990 that there was an excellent [research site] on an island that had been isolated from the rest of the world. We ended up going to Bioko in 1990, and we found plenty of drills, but the thing I fell in love with, really, was the island. I just thought it was a spectacular place."

And by all accounts, that's exactly what it is: An island covered in a rain forest of stunning beauty—lush and green, thanks to the 35 feet of rain that falls each year—accented by soaring cliffs, cascading waterfalls and, of course, incredibly diverse wildlife. It is home to one of the greatest concentrations of primates (the drills included) in all of Africa, a dizzying array of butterflies and nearly 200 species of birds. To the north, there is the Pico Basile National Park, and north of that, the island's one commercial center—the capital city of Malabo, home to 100,000 residents, many who work in the oil business. It is not a completely pristine place, but it's certainly a unique place—and to Hearn's mind, one worth saving.

"It wasn't so much about the drill monkeys," she says. "It was about the biodiversity. Could we save the spectacular ecosystems of this island? I never had any illusions about being Jane Goodall. I was married. I had kids. I never really wanted to live out in the rainforest in a tent for weeks and weeks at a time. But I did feel this was a place where I could make a difference."

Through the BBPP, that's precisely what she's set out to do. First launched in 1997, the program has grown into an academic partnership between Drexel and the Universidad Nacional de Guinea Ecuatorial, with the stated aim of helping conserve the island's remarkable biodiversity. The drills, it seems, stand at the center of the effort. According to BBPP officials, the "dramatic loss" of population among the island's seven monkey species represents the most immediate threat to the island's long-term environmental health. Though it's been difficult to get an exact estimate of just how many drills live on the island, both Honarvar and Hearn say their team has been able to compile enough data to conclude that hunting pressures have done serious and perhaps lasting damage. More than that, they say that if the hunting is allowed to continue, the drills could very well be pushed to the brink.

The most depressing thing about that, they say, is this: The carnage could be stopped tomorrow.

That is, if the government actually wanted it to stop. "It's so easy," Honarvar says. "You just take the guns away."

"The single biggest pressure on the drills is hunting. When they take the guns away, the hunting goes down. We have data showing this. [But] when they stop enforcing the laws, [deaths] go back up."

CHANGING A CULTURE

The hunting of monkeys is illegal on Bioko. And in years past, when the government has decided, for whatever reason, to actually enforce the anti-hunting laws, the impact has been both plainly apparent and immediate.

Putting it bluntly, Honarvar says, when the hunting is banned, dead monkeys stop showing up at the markets.

THE_FILM

The Drill Project features the first-ever broadcast images of wild Bioko Island drills and tells a tale about their biology. An educational film,

The Drill Project illustrates the beautiful relationships formed in the biodiversity of Bioko Island's tropical forests, and explains how the drills are an important part of their ecosystem. Viewers learn that not all is well in these forests, as traditional bush-meat hunting practices have given way to commercial poaching with shotguns. *The Drill Project* gives a voice to the drills and the six other species of monkeys on the island by exhibiting these lesser-known primates' struggle with human misunderstanding and advocating the abolishment of primate hunting on the island. Watch the film online at thedrillproject.org.

"In 2007, the president came out with a decree banning the hunting of monkeys, and we went out to count dead monkeys in the markets," Honarvar says. "Very quickly, that number went down to zero—and then, when they stop enforcing the law, it goes back up. Later, the minister of the interior started talking to people in the markets, telling them that they were no longer allowed to sell monkeys. Again, the number of dead monkeys went down to zero. But within a couple of months, it shot back up again."

"I think the population is on the cusp, yes," Hearn says. "We're trying to do what we can, but the reality is, it's very easy to save the monkeys. The government merely has to enforce its own laws. They could do it in a day if they wanted to."

Of course, that's much easier said than done. And cultural differences—differences between the way Hearn and Honarvar see the rainforest, and how Bioko islanders see the rainforest—are the biggest reason why.

To the Drexel researchers, Bioko is a treasure—a gift to the world of science, a refuge for an untold number of species, and one of the last remaining bastions of unspoiled rainforest in the world. But to the islanders? Well, to most of them, it's just home. And the rainforest, while romantic and rare to many outsiders, is to them mostly an annoyance—a place they mostly want to get away from, not return to, and certainly not a place they believe needs to be "saved."

"Making it" in Bioko, Hearn says, means landing a cushy job in an air-conditioned office, working behind a computer and making enough money to live well in Malabo. "Making it" most certainly does not mean doing research in the rainforest. It's this gulf of perspectives that has made selling residents on "saving" the island so difficult.

By extension, it's made their efforts to convince government officials to enforce hunting laws nearly impossible.

"In many cases it's the people in the government who are eating the monkeys, and who profit from the hunting of the monkeys," Hearn says. "Now, there are forces of good in the government who realize that [preservation] is important for the long-term pride of the people in that country. They know that the opportunity is there for ecotourism, but while the monkeys are present in incredible density on the island, when you walk through the forest, you don't see the money. If the people decide that it's important to save them, though, then the government is forced to act; the forces of good would use that groundswell of support to say, 'Yes, we can enforce these laws,' and the forces of bad would say, 'Yes, I guess we have to.'"

In a sense, this is where the film comes in. It is one of the biggest weapons the Drexel team has in its public relations war to win over the islanders.

The film simply deals with facts and reality. It presents the drills as Honarvar and her team saw them in the wild—which, notably, is not how most islanders have seen them.

For so many islanders, Honarvar says, the monkeys have traditionally been seen as they are presented in the market—as a commodity.

In the wild, however, they can be seen for what they are: Highly social, deeply family-oriented animals who live much like we do. At market, they are presented as commodity; in the wild, they are mothers and fathers and babies.

"The local people have never seen the drills like this," Honarvar says. "They only see them when they're dead, in the market."

It is Honarvar's hope that being able to see what she has seen will eventually convince locals that the monkeys shouldn't be eaten, and the hunters that the monkeys shouldn't be shot. And make no mistake, she says, at the moment, the hunters show no mercy in pursuit of their $300: Babies are just as likely to be sold as adults.

"The hunters will kill whatever they can," she says. "They'll kill a mother with infants. They'll eat the mother and sell the baby."

In other words, yes, there is much work to be done—and a huge gap to be closed. Neither Hearn nor Honarvar believe that winning over the islanders, or saving the forest, will be easy. It may take years and, ultimately, it may never happen. But they say the effort—the film, the research, the students working at the site via study abroad, the engagement with locals, the BBPP project—is more than worth it.

"The single biggest pressure on the drills is hunting. When they take the guns away, the hunting goes down. We have data showing this. [But] when they stop enforcing the laws, [deaths] go back up."

-Shaya Honarvar, research associate in the Department of Biology

"Something like this film is just part of the process," Hearn says. "As you have people seeing more and more things—posters, brochures, town meetings—that tell them they shouldn't be eating the wildlife, or that in the long run they need to keep the animals in the forest because it might be the [economic] answer when the oil runs out, it helps. And really, there's no quicker way to get the message than to put a film on national television."

The documentary—*The Drill Project*—debuted in December 2012 on television in Equatorial Guinea. It has since been broadcast online and picked up by many conservation websites, including Mongabay.com, the African Conservation Foundation and the Humane Society. Not only that, but Honarvar and her colleagues have submitted the documentary to various film festivals—and it has already been accepted into the Wildlife Conservation Film Festival, scheduled for October 2013.

At it's core, the argument from the filmmakers, and from BBPP, is blunt.

That message is this: The clock is ticking. To save the monkeys. And, in a sense, to save the island, too.

Says Honarvar: "This is not our film. This is their film. It's about their country, and it's about their wildlife."

_ONLINE
To learn more about Honarvar's research and to see the film, visit **EXELmagazine.org**

_ONLINE
To read the full-length articles that appear in this section, visit **EXELmagazine.org**

FOOD SAFETY

_FOOD SAFETY, FROM A DIFFERENT PERSPECTIVE

Drexel's Jennifer Quinlan is shedding light on an area of ***food safety research*** *that has typically been underrepresented–and providing tools to combat unsafe practices.* _by Danica DeLizza

Traditionally, most food safety research has occurred in food microbiology labs at land-grant universities often located in rural areas. When Jennifer Quinlan came to Drexel, she saw a need for food safety research that addressed the unique aspects of urban areas and their populations. She therefore set out to secure grants that would allow her to study food safety issues for minority and low socioeconomic populations, which are underrepresented in food safety research.

Quinlan's first U.S. Department of Agriculture grant in 2005 allowed her to survey food quality in small urban markets in comparison with larger suburban supermarkets. Data obtained in that SEED grant study allowed her to apply for and receive a larger USDA grant that she used to study 360 retail stores in a variety of Philadelphia neighborhoods—low socioeconomic, high socioeconomic and some composed of ethnic minorities. This study involved auditing stores for their food safety practices, such as testing temperatures inside the stores and determining the quality and safety of food available to populations of different demographics.

Through these studies, Quinlan and her students found that in low socioeconomic markets, food is more likely to be old or spoiled. However, when it comes to food safety inspections, it seems that inspector bias may be at play when establishing standards for retail stores in low-income areas versus high-income areas.

"We saw higher violations in higher income areas…If you're inspecting a large chain supermarket and they have all these resources [to maintain food safety] you hold them to a higher standard, but you're not necessarily out to put every little guy out of business," Quinlan says.

"[Rinsing raw chicken before cooking it] doesn't kill or eliminate the bacteria, but does have the potential to further spray it around the kitchen area."

Quinlan's research has been published in the *American Journal of Preventive Medicine, the Journal of Food Protection and Applied and Environmental Microbiology*.

Quinlan's research is based on data that shows foodborne illness is often found more in low-socioeconomic and minority populations, which begs the question: Do low-income populations have greater rates of foodborne illness because of retail access to food or because of consumer handling after the food is purchased?

Quinlan's current USDA grant used focus groups and surveys to try to identify if there were any unique unsafe handling practices among minority ethnic consumers. Instead, Quinlan and her research team found an overarching habit held by people across all demographics—rinsing raw chicken before cooking it, a practice Quinlan explains "doesn't kill or eliminate the bacteria, but does have the potential to further spray it around the kitchen area."

Raw chicken has a high chance of being contaminated with salmonella or campylobacter, but cooking the meat appropriately will eliminate both forms of bacteria. Rinsing the chicken in water creates an aerosol spray that can spread the bacteria onto surrounding surfaces, increasing the risk of cross-contamination.

In response to this unsafe practice, Quinlan and her team have launched an awareness campaign using materials developed with their collaborators at New Mexico State University. The materials include a series of photo novellas designed to explain the dangers of rinsing raw chicken. Additionally, the photo novellas include recipes to encourage people to prepare meals from fresh ingredients rather than using frozen or processed foods.

This campaign includes a website as well—drexel.edu/dontwashyourchicken. In the coming months, the materials will be available for distribution at Philadelphia libraries in an effort to pilot the materials and educate the public about safe food-handling practices.

_JENNIFER QUINLAN
Quinlan is an associate professor in the Nutrition Sciences Department in the College of Nursing and Health Professions.

KITCHEN_TIP
Quinlan suggests putting raw poultry straight from the package into the cooking pan. The heat from the cooking process will kill any bacteria that are present.

_ONLINE
For more resources and to watch Quinlan's photo novellas, visit **EXELmagazine.org**

_WHAT'S IN IT FOR THEM?

CEOs of acquired firms are awarded ***merger bonuses*** *in 25 percent of all deals, according to a LeBow College of Business researcher.*

In about one in every four deals, the CEO of an acquired firm is awarded a merger bonus, according to a recent study that examined more than 949 merger and acquisition offers that occurred in the United States between 1999 and 2009. The study also found that target shareholders received inferior premiums when their firms were sold while their CEOs received a merger bonus.

According to the study's authors—LeBow College of Business' Eliezer Fich, Edward Rice from the University of Washington and Anh Tran from the City University London—for the average deal the presence of a bonus is associated with a decline in the acquisition premium of 3.87 percent. Such a decline implies a drop of about $186 million in terms of deal value for target shareholders. Target CEOs in these transactions are paid merger bonuses that average $1.6 million but can be as high as $12 million.

Because of this evidence, the authors examined whether bonuses identify a conflict of interest between CEOs and shareholders when their firms become acquisition targets but found that this doesn't necessarily indicate shareholder expropriation or nefarious managerial behavior on the part of the target CEOs that get a merger bonus.

"At first glance, one would be tempted to conclude that target CEOs who get a merger bonus sell out their shareholders for their own personal gain," according to the authors. However, their study also shows that merger bonuses are often tied to legal agreements that prevent the target CEO from competing against the merged firm. The return to the acquiring firms is not higher when target CEOs receive a merger bonus. Based on these additional findings, the authors argue that in transactions in which target CEOs get a merger bonus, acquirers pay less for the targets, but they also buy less in the form of low synergy targets.

The authors conclude that bonuses arise endogenously when takeovers generate small synergy gains, and either encourage target CEOs to act in the interest of their shareholders or don't affect CEO actions.

1 in 4

Number of deals in which the CEO of an acquired firm is awarded a merger bonus. Meanwhile, target shareholders receive inferior premiums when their firms are sold.

_INSIDE THE LYRICS

_DONALD TIBBS
Tibbs is an associate professor of law in the Earle Mack School of Law.

If you listen to hip-hop music only to enjoy the beat, you're missing out. But it's not your fault, says Donald Tibbs, a law professor who specializes in race, crime and punishment. Most people don't know how to take the lyrics from a hip-hop song and think about them in a deeply critical way. Through his research and teaching, Tibbs is trying to change that.

Tibbs first introduced hip-hop lyrics into his coursework back in 2009 with one particular goal in mind—"to change minds," he says. On the first day of class, he posted the lyrics to *99 Problems* by rap artist Jay-Z.

"I wanted to show my students that I can teach them everything about constitutional criminal procedures and police investigations from this one verse of this one song—every single line connects to a different case that we were going to talk about that term. Every line connects to about three or four different legal cases, and my goal is to show you where those connections come from," says Tibbs.

Hip-hop music, Tibbs says, is a way to tell the story of the war on young black men in America.

Tibbs explored this topic in detail in a paper published in 2012 in the University of Iowa's *Journal of Race, Gender and Justice*. In "From Black Power to Hip Hop: Discussing Race, Policing and the Fourth Amendment Through the 'War on' Paradigm," Tibbs examines this war on young black men through hyper policing in America, and the way that constitutional rights for young black men are violated every single day. He wanted to show how these violations changed—and stayed the same—from the post-Civil War era to the post-Black Power era.

CRITICAL_EAR
Tibbs is sharing his experience with hip-hop in a new book, "Reading Hip-Hop, Teaching Law," due for publication in late 2014.

Last spring, Tibbs taught a new kind of law course: Hip-Hop and the American Constitution, the first course at an American law school to focus solely on hip-hop, he says. After receiving a grant from the Office of the Provost and matching funds from the law school, Tibbs was determined to show students that hip-hop has a story to tell. The course brought together scholars from across the country who were separately researching the connections between hip-hop and the law.

"There is a multitude of legal scholars who are out there writing about hip-hop in bits and pieces and we are all sort of scattered," Tibbs says. "I wanted to bring everybody together through a lecture series and have my students see that hip-hop is not only valuable in the post-modern world and in popular culture, but it also has significance to legal education and, more importantly, legal practice."

Tibbs says he wants law students to see that pop culture, in particular hip-hop, and the law fit together quite neatly.

"As we become a more pop culture-driven society, it's important to think about the ways the practice of law is affected by popular culture," Tibbs says. "Hip-hop brings up every single thing that might be related to some aspect of the practice of law—whether it be criminal law, criminal procedure, contract law, intellectual property, evidence, property rights, business corporations—everything that students might go out and experience as practicing lawyers."

SPORT MANAGEMENT

_A NEW VOICE

Drexel's Ellen Staurowsky has spearheaded a blog focused solely on ***LGBT issues*** *in sports.*

Sport, as an institution, has historically been behind the times when it comes to issues related to the lesbian, gay, bisexual and transgender community. But a growing push for social justice in sport has begun to transform cultural attitudes.

The Goodwin College of Professional Studies recently launched the blog, "LGBT Issues in Sport: Theory to Practice," which aims to be the definitive resource for research on LGBT issues in sports.

Ellen Staurowsky, a professor of sport management, founder of the blog and internationally recognized expert on social justice issues in sport, says she believes we're at an "interesting moment" in society—by "interesting," she means that while great progress has been made to address LGBT issues in sport, discrimination and hostile environments are still a reality for LGBT individuals, and now is the time to make serious change.

_ELLEN STAUROWSKY
Staurowsky is a professor of sport management in the Goodwin College of Professional Studies.

She's hoping this blog is a step in the right direction.

The blog serves as a forum, a kind of meeting place, for more than 25 experts and activists from around the country, who have agreed to contribute regularly to the website, sharing their perspectives on issues that affect athletes, coaches and administrators at U.S. colleges and universities. They aim to make significant contributions to the dialogue around homophobia and sexual prejudice in college sport with the ultimate goal of eradicating the hostile climate for sexual minorities in sport within the next five years.

"I felt like we had a hidden treasure in terms of the expanse of scholars who were doing work in this area," says Staurowsky. "The problem was that their work can sometimes be very discipline-bound, where people who are working on the same topic within the same institution may not even know, from one department to another, that they have a shared interest. This research was known to a very small group of people, in the grand scheme of things."

Establishing the blog, Staurowsky says, was an attempt to "unlock that treasure a little bit and share it with a broader audience."

"I see us developing curriculum and classroom experiences for students. In my classes, my students will be required to contribute to a blog project of one sort or another, and this blog could

LAW

_FLAWED SYSTEM

_RICHARD FRANKEL
Frankel is the director of the Appellate Litigation Clinic and an associate professor of law in the Earle Mack School of Law.

Drexel's Richard Frankel says a description of his research is hard to pin down. But his objective is crystal clear: to protect individuals—in particular, low-income individuals—whose rights have been violated at the hands of a large institution, corporation or government agency. It's a scenario that often surfaces in the context of immigration policy and law, a topic Frankel explores in a paper recently published in *Southern Methodist University Law Review*.

In "Illegal Emigration: The Continuing Life of Invalid Deportation Orders," Frankel outlines a flaw in the justice system when it comes to immigrants and deportation law. He explains the difficulties faced by immigrants deported by the government who have succeeded in overturning their deportation order in another country, after the government has removed them from the U.S. The reversal of a deportation order ordinarily restores non-citizens to their prior status of being lawfully present in the U.S.

But federal immigration authorities have used the fact of the non-citizen's now-invalidated deportation to subject them to different and "harsh" standards that effectively prevent them from returning. Under this practice, Frankel writes, non-citizens who seek to return after winning from abroad are treated as "arriving aliens," meaning that because they are now outside the U.S., the government can keep them out, even if they never should have been removed in the first place.

Deportation, Frankel writes, is one of the most severe punishments that the government can inflict upon non-citizens. The inability of wrongly deported immigrants to return is a significant and growing concern.

"The impact of being deported outside of the U.S. is so significant on the person and their whole family. They may have small children or family members relying on them to earn money."

"The impact of being deported outside of the U.S. is so significant on the person and their whole family," Frankel says. "They may have small children or family members relying on them to earn money. It's just so disruptive. In many cases, it can be permanent; some might have to wait 10 to 20 years before they can reapply to enter the country."

_SEEING RED

Four researchers, including marketing professor Rajneesh Suri, found that men are quicker than women to interpret red prices on advertisements as bigger savings.

Advertisements are an increasingly prevalent visual throughout a person's day, bombarding the consciousness whether in print, on billboards, in stores, on mass transit, on television or online.

Retailers adopt various methods of reaching customers, including the use of colors and, in particular, the color red on price tags to attract buyers. In a research paper titled, "Are Men Seduced by Red? The Effect of Red Versus Black Prices on Price Perceptions," four researchers, including LeBow College of Business' Suri, found that men judge red-colored retail prices as larger savings, while women are more skeptical.

This research focuses on how numbers are presented. Would the price for an item that is shown in red ink spur different reactions if it was in black?

Suri and his colleagues conducted numerous studies, four of which were included in their paper, which tested graduate school students. Everyday items, such as toasters and microwaves, were designed on mock retail ads. The first study focused on examining men's and women's reactions on how much they thought they were saving, the second judged their emotional state while reading the ad, the third used a multi-ad process to rule out novelty and accumulate more evidence and the fourth study manipulated men's involvement—in other words, it influenced males to engage in deeper processing.

The studies found that men feel more positive than women when prices are presented in red and perceive the retailer is offering a better deal. Women are more likely to elaborate on the ad. They exhibit better memory for price information, which in turn makes them suspicious of the retailer's use of red to highlight prices.

Suri and his colleagues base their findings on the concept that women are deeper processors of information.

"That's a genetic makeup of women," Suri says. "Because they're deeper processors, they tend to challenge deals...while men avoid thinking through it."

_TWEETS

When news breaks on Twitter, it's easy to let 140 characters after 140 characters disappear into the depths of the constantly refreshing news feed.

It might be an inconvenience for tweeters hoping to catch every last bit of commentary, but it poses an even bigger problem for scientists looking to study patterns in social media.

Enter TwitterGoggles, a program—developed by doctoral student Alan Black, master's student Michael Gallagher and iSchool-College of Information Science and Technology associate professor Sean Goggins—that collects and saves tweets on a given topic to be analyzed by a team of computer scientists.

So far, Goggins and his team have collected more than 400 million tweets on cultural topics related to math, learning and breaking news.

"The ultimate goal is to be able to understand what are the categories of behavior in social media in technology—how do organizations emerge?"

"We take what we've learned to find ways of probabilistically estimating the likelihood of the behavior of people."

Goggins says of TwitterGoggles, which originally went by the name TwitterZombie, "We take what we've learned to find ways of probabilistically estimating the likelihood of the behavior of people."

_RAPE LAW REFORM FAILURE

_ROSE CORRIGAN
Corrigan is an associate professor of law and politics and the director of the Women's Studies Department.

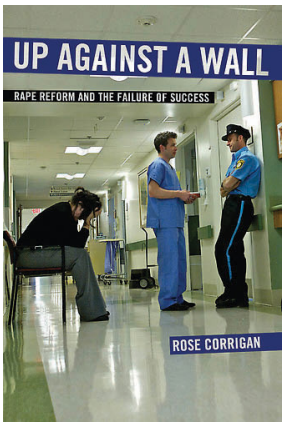
Debates about the term "legitimate rape" and whether a woman's body can prevent rape permeated media coverage in 2012, shedding light on the fact that views about sexual assault victims continue to be outdated, biased and insensitive, and that victims still lack real rights and protections.

In her newest book "Up Against a Wall: Rape Reform and the Failure of Success," Drexel law and politics professor Rose Corrigan explores the ways in which reforms designed to protect the rights of rape survivors have failed and, in some instances, even backfired. It also examines how state-level policies affect the work of local rape care providers, especially their relationships with medical and legal institutions.

The book draws on interviews with more than 150 local rape care advocates in communities across the United States to explore how and why mainstream systems continue to resist these reforms. *Ms. Magazine* named the book a "Great Read for Fall 2012." Corrigan, who holds a joint appointment with Earle Mack School of Law and the College of Arts and Sciences, has focused her research on law and social movements, particularly on the ways that law has shaped movements to respond to sexual and domestic violence.

"As I spoke with advocates working in rape crisis centers across the U.S., what I discovered painted a disturbing picture of medical and legal responses to victims of sexual assault," Corrigan says. "In many communities, medical personnel make victims wait for hours for treatment, police are dismissive of the seriousness of rape and prosecutors routinely decline to charge cases that they deem 'difficult.'

"Without a frank discussion about the continuing problems with legal and medical responses to rape, new policy initiatives may compromise—rather than



strengthen—fair, competent and compassionate responses to sexual assault. My hope is that telling these stories might help rape crisis centers, state coordinating coalitions, communities and policymakers develop more effective responses to sexual violence that acknowledge the relationships among law, policy and gendered inequality."

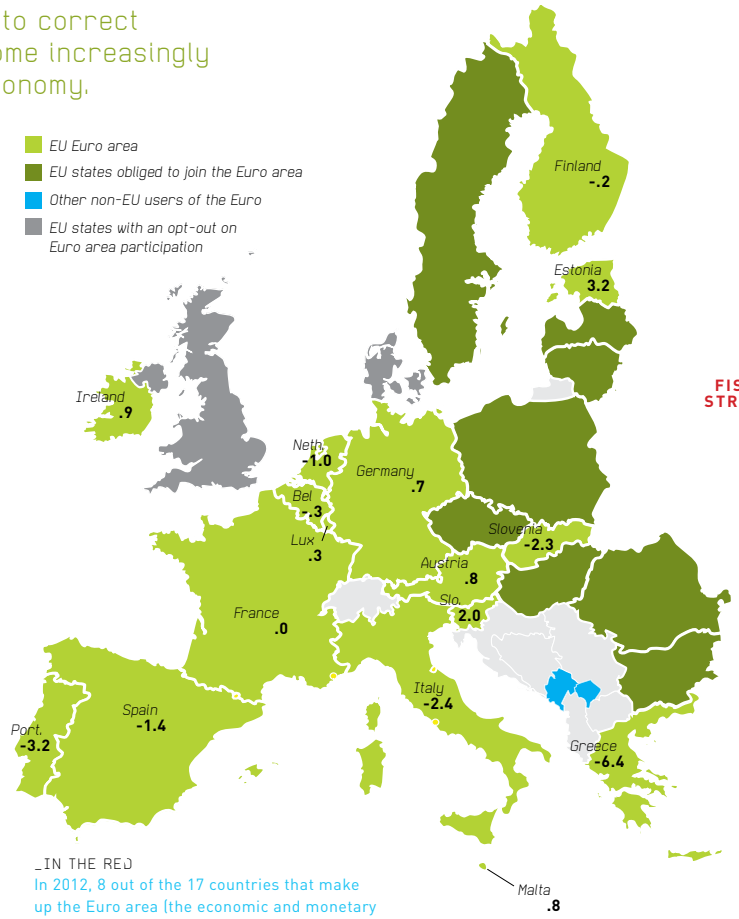
_SLIPPING BEHIND

Europe is beset by a host of severe economic problems, says Marco Airaudo. Unless something is done to correct them, the region may become increasingly irrelevant to the world economy.

BEING FROM ITALY, ECONOMIST Marco Airaudo has taken a keen interest in the economic structure of Europe, which is undergoing more than its fair share of economic woes these days. The turmoil has gripped Greece, Ireland, Portugal and other nations, and to hear Airaudo tell it, the continent's three biggest problems are indeed tricky ones: low growth, public finances and unemployment.

In the last 20 years, the annual growth rate in the Euro area—the countries sharing the Euro (its current value is approximately $1.3 per Euro, while it was around $0.85 per Euro 11 years ago when the Euro became Western Europe's official currency) as common currency—has rarely exceeded 1 percent. Thus, European countries are unable to compete with the thriving economies of India and China.

"If we want the Euro area to survive future global crises, we need to rethink the whole structure of the European Union. Having a centralized monetary policy and several decentralized—and effectively rather arbitrary—fiscal policies, as we have now, is problematic," explained Airaudo. "We need a clear and effective fiscal mechanism of risk-sharing across European countries, on which all countries have to agree, in bad times and in good times. This is the way the United States federal system works. Since the Euro area was created with the U.S. as a model, we need to make that extra step."

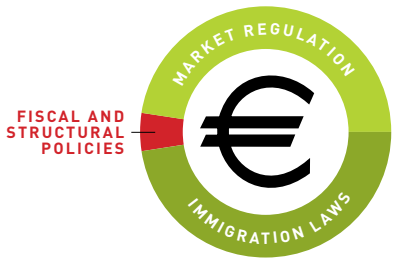


_IN THE RED
In 2012, 8 out of the 17 countries that make up the Euro area (the economic and monetary union of 17 European Union member states that have adopted the euro (Đ) as their common currency and sole legal tender) saw a negative GDP growth rate.
source: Eurostat

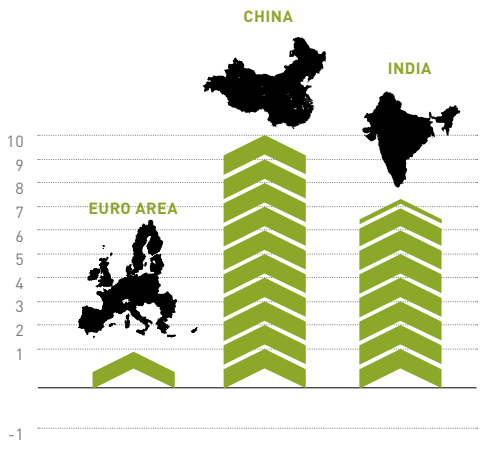
_VOLATILE CURRENCY
In 2011, the value of the Euro rose to a high of $1.4675, but just one year later, it had fallen to $1.2176. The decline was a result of a number of factors, one being the Greece debt crisis.

12%

Average unemployment in the Euro area. This means about 18 million people are seeking jobs and not getting one. At the lowest end, Austria's unemployment is 5 percent. At the highest end, unemployment in Greece and Spain is 27 percent.

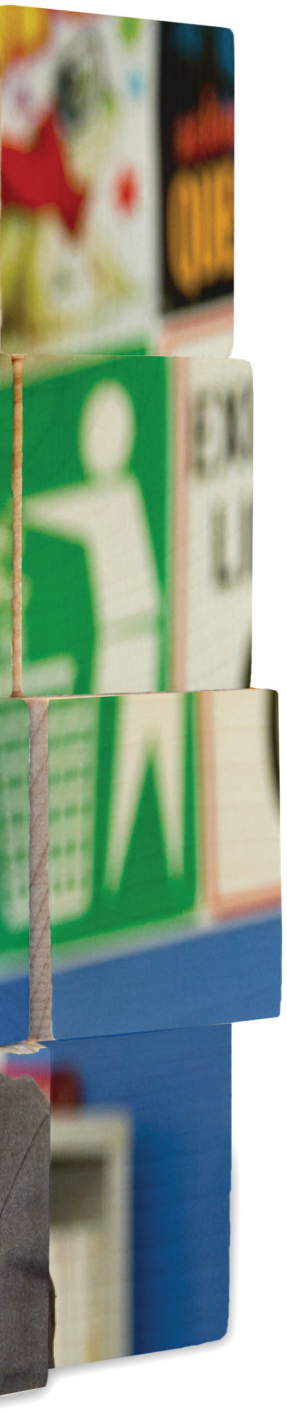


_LIMITED ROLE
At the moment, the EU's power is mostly concentrated in market regulation and immigration laws, while—with respect to fiscal and structural policies—its role is much more limited. Having a concerted fiscal policy plan at a Europe-wide level would have probably helped tackling the crisis.



_CAN'T COMPETE
From 2005 to 2012, China and India have experienced significant growth with an average GDP growth rate of 10.9 percent and 8.2 percent respectively. The European Union, however has only grown by an average of .8 percent since 2005.
source: worldbank.org


important
LAUGH



_STACKING UP

SHEILA VAIDYA HAS STUDIED PHILADELPHIA SCHOOLS UP CLOSE, AND SHE KNOWS WHAT THEY LACK: GREAT TEACHERS. THROUGH HER NEW MASTER TEACHER INITIATIVE, SHE IS AIMING TO PROVIDE THE CITY'S STRUGGLING SYSTEM WITH A MUCH-NEEDED BOOST.

_by Maria Zankey

"I could sit in a classroom, always," says Sheila Vaidya from the lobby of Mastery Charter School's Lenfest Campus. She's interrupted by the ring of the school bell, and after a rumble from within the classrooms, students flood the hallway, backpacks slung off of shoulders and white headphones dangling around necks.

"They can be a little loud, but that's kids," Vaidya says with a smile. "These students are good kids, and they're good learners."

But Vaidya, an assistant professor of education, says eager students are only one part of the equation when it comes to creating and sustaining successful schools. The other part, of course, comes from educators themselves.

After years of working as a school psychologist in the School District of Philadelphia, Vaidya says she's noticed that second part of the equation simply isn't there, because if there's one thing the city's school system lacks, it's effective, inspiring teachers.

"I was really surprised to visit some of the schools in Philadelphia," says Vaidya. "Kids were so disengaged. They were making fun of the teachers, making fun of math and the rest of their subjects. It wasn't good."

The disconnect she witnessed in schools throughout the city was enough to propel her into action. Seeking to make a difference in a system that badly need change, Vaidya began to write proposals for grants that could enhance the teachers' experience, with the hope that the benefits would trickle down to the students, the school district and, ultimately, the region.

So far, Vaidya's efforts have been wonderfully successful. Since 2007, she's received four grants for teacher enhancement programs, and at Mastery, the students and teachers have already felt the reverberations of her most recent National Science Foundation-funded venture. The venture, called the Master Teacher program, aims to help teachers become masterful at their craft, inspire their students and set the foundation for lifelong learning.

It's an effort that could pay dividends for years to come.

"When you think of people who have grown up, and you think of how they've succeeded, there's always the story of a teacher there," Vaidya says.

DEFINING 'MASTERY'

The Master Teacher initiative is rooted within the Noyce Program—a scholarship opportunity for students of education to train and eventually become Science, Technology, Engineering and Mathematics teachers in high-need schools. Vaidya is the director of the Noyce Program and principal investigator for the Master Teacher program, which is supported by a supplemental grant to further train teachers—and, hopefully, develop true "master teachers"—already teaching in Philadelphia schools.

It's a huge challenge, and one that starts with the very basics: Identifying what master teachers should be, and how they can be cultivated.

"No one has agreed upon the definition of a 'master teacher,'" Vaidya explains. "That's why the NSF tasked us with developing master teachers: because their idea was that if we have a model for developing them, we could replicate that all over the country.

"We're looking at this as a career trajectory. When you look at a teacher's path, you have pre-service teachers, who are students, then in-service teachers, who are actively teaching, and then from there, where do the good teachers grow to?"

"We think that good teachers can become what we call 'master teachers,' and that eventually they should be recognized for that in the system," Vaidya adds.

But what sets an educator apart as a master teacher? Or even just a potential master teacher? Vaidya and her colleagues are still trying to define the fine print, but there's one qualification that is already agreed upon.

"It all comes down to student achievement," Vaidya says. "If students don't show learning improvement, if they're disengaged, then no one wants to be involved in this business. And that is the business that we're in—all teachers should simply want students to be able to excel."

BEYOND THE BASICS

In a Mastery classroom, teacher Joji Thompson preps for his third period, 11th grade physics class. Instead of doling out blue books to each student, he's handing out handmade cubes, each side containing a series of clues. As the students file in, they're instructed to work together to discern patterns among the cubes and ultimately solve the day's puzzle.

"In most science labs, we tell students what to do—measure the ramp, the speed," Thompson says. "It's not science—that's me telling students what to do, and them obeying. What I want to get across to these students is that there's more to science. Scientists don't always have the right information, they don't automatically know the patterns, or have the best equipment. So you have to experiment and debate—and as students I need them to understand that framework for scientific discourse."

Thompson is one of three master teachers-in-training working with Vaidya in the Master Teacher program. The cube logic lesson he's using is something he's picked up as part of his master teacher training—a professional development opportunity at a NASA conference in San Luis Obispo, Calif.

"That is part of the beauty of the Master Teacher program," Thompson says. "I'm offered support, feedback and professional development to get that excellence out of my students. In turn, I provide Dr. Vaidya with data based on how my students are improving."

Thompson says that as part of the program, he sets personal goals at the beginning of each school year. Every six weeks, his students are tested, and the results are compared to the scores of the other 600 students at Mastery. Each month, he submits his data to Vaidya, with the hopes of seeing improvements in each student's scoring.

"Joji was masterful before he even entered the program," Vaidya says with a laugh. "He sees the capacity of the students and then takes it to the next level."

Thompson's knack for teaching was something Vaidya noticed from afar; she jumped at the chance to harness it. As an undergraduate engineering student at Drexel,

FUNDING_TEACHERS

The Noyce Program is a National Science Foundation initiative that seeks to encourage talented science, technology, engineering and mathematics majors and professionals to become K-12 mathematics and science teachers.

Thompson began tutoring students in Japanese and mathematics at the Drexel Learning Center, and later the Drexel Dragon Program—summer workshops for students who were accepted to Drexel but whose grades were on the lower end of the spectrum.

"Students were really struggling with completing the square, in particular, so I made a DVD that walked them through step by step using graphics," Thompson says. "That DVD caught the eye of some people in the education department, and I was asked by Dr. Vaidya to come in for a meeting. She asked me to try out education to see if I liked it or not—and I did—so they offered to help fund my education degree through the Noyce Program."

After graduating from Drexel, Thompson moved to Japan for a year, then returned to Philadelphia to teach.

"I landed a job at Mastery," Thompson says. "Our students are chosen by a lottery system. We don't pick 'the best' kids. We take kids from all over the city whose schools say they are 'failing,' four or five grade levels behind."

To qualify for the Master Teacher program, teachers must have a master's degree in education. More importantly, probably, they must be highly motivated, innovative and continually striving for student achievement.

Thompson fit the bill without question, Vaidya says.

"Joji is an example of the fact that when there is a certain amount of support—and he's getting as much as we can give—teachers and students can excel," Vaidya says. "Some teachers in schools get no support. When teachers put in many hours behind the scenes, when they care about the achievement of their students, and when they have the resources to do so, it shows in the students. We've seen that here at Mastery and in Joji's classroom and we have the data to prove it."

Vaidya says she collects testing data, grades, PSSA scores, evaluations and any other data that might be available from within the classrooms. But not every school is as vigilant in collecting data as Mastery—and Vaidya says the task of quantifying the value of a good teacher is one of the biggest challenges the program faces.

THE LEARNING CYCLE

As Thompson commands his class, Vaidya observes him—and his students, too. She's collecting information that can't exactly be tallied in an Excel spreadsheet. One student calls Thompson by first name, and he responds to her warmly. Another has a question about the semantics of a pop quiz; she raises her hand confidently, without hesitation.

"The students really respect Joji," Vaidya says. "They trust him. That's something you can't teach or train."

But Vaidya says enthusiasm is contagious—and that's something she's hoping can overpower the lack of data when developing a master teacher model.

"Having master teachers also comes down to increasing the teaching capacity in schools, so that there will be a corps of teachers in every school," Vaidya says. "We want to have more Joji's, who can inspire other teachers to learn new things. We've seen that happen in other schools. When teachers are using certain technologies or certain methods of working with their students, other teachers replicate that. Schools will develop and enhance themselves when there's a teacher-learning community. There's not much of that community in the field yet, especially in high-need schools."

"When you think of people who have grown up, and you think of how they've succeeded, there's always the story of a teacher there."

To help foster a community of effective teaching within schools, master teacher candidates are required to keep a portfolio of their work—innovative teaching techniques, professional development lessons, advice from colleagues they've found useful on their quest to become masterful.

"To become 'masterful,' it's a very gradual learning process," Vaidya says. "There's no real finish line in the process. When teachers go through the program, we can say they are master teachers, but we will never say, 'That's the end for you.'"

Going forward, Vaidya says she hopes to establish levels of master teachers, emphasizing the importance of lifelong learning.

"We want to eventually categorize certain teachers as master teachers, partly to recognize and reward those who are putting in extra effort in teaching, and partly so they can become a role model for others. But becoming a master teacher is a lot of hard work," Vaidya says. "There are some people who may want the recognition—to become a master teacher—but who are not prepared for the hard work involved."

The goal of the program is not to attain the master teacher title and relax, Vaidya says.

It's to achieve excellence, and then convince the teachers to work even harder.

"If people don't like to be studying and learning new things all the time, they shouldn't go into teaching," Vaidya says. "In physics, for example, there are labs all over the country who are doing physics research. That's why professional development is so important in education, but it's rarely stressed. Not only does Joji have to know that, but he has to be able to understand what they're doing so he can teach his students to the best of his ability."

And ultimately, that's what's at the core of the program: improving teachers who, in turn, will improve student achievement.

"When you think of your life's trajectory, if you're not highly educated, what options do you have?" Vaidya says. "There are a few people who can be Bill Gates. It is not impossible to be successful without an education, but you have to have an innate talent, and often, it depends on your life's circumstances. Education sets an even playing field, and every student deserves a teacher that will open their life to opportunity."

JOJI_THOMPSON

While studying engineering as an undergraduate student at Drexel, Thompson was approached by Sheila Vaidya to pursue a master's in education. He now teaches science courses at Mastery Charter School's Lenfest Campus.

'WE CREATED HIM'

In this excerpt from his recently released book, Drexel political science professor George Ciccariello-Maher argues that discussions about Venezuelan politics far too often focused on ***Hugo Chávez****, the man who sat in the president's office, rather than the movement–and the people–who put him there.* _illustration by Edel Rodriguez

"Who are you? What are you doing here?"

_GEORGE CICCARIELLO-MAHER
Ciccariello-Maher is an assistant professor in the Department of History and Politics in the College of Arts and Sciences.

When we got to La Piedrita, they already knew we were coming. If not for the phone call they received from a trusted comrade, then from the video cameras lining the perimeter of this revolutionary zone that jealously guards its autonomy from all governments, right or left. If not from the cameras, then from the network of eyes dispersed across the community, always alert to unknown or unrecognized individuals. And if not from all that, then certainly from the guard at the top of the rickety stairs that climb from the parking lot of the apartment blocks into the chaotic jumble of the barrio that lay behind it. He greeted us down the barrel of a chrome 9 mm pistol with stern questions: "Who are you? What are you doing here?" If we didn't have good answers for these questions, there might have been a problem.

But indeed, we had an excellent answer: two short words, "Valentin Santana."

Just minutes before, my photographer and I had been enjoying the warm June dusk a few blocks below, near a small park in the Monte Piedad neighborhood of 23 de Enero, a notoriously revolutionary area of western Caracas perched precariously above Miraflores Palace, the nominal seat of state power. We were chatting, laughing, drinking beer and miche—a surprisingly potent homemade firewater distilled from sugarcane—while others play dominos, when a new friend raised the inevitable question of why we were there. We had come to understand the revolutionary collectives that constitute Venezuelan President Hugo Chávez's most radical support base, to grasp their political vision and their often-tense relationship with the process of political transformation known as the Bolivarian Revolution. Had we gone to La Piedrita? No, we hadn't. Our only contact with the collective had been gazing in awe at the nearby murals surrounding their zone of influence, the most spectacular of which is a massive image of Jesus holding a Kalashnikov, bearing the message, "Christ Supports the Armed Struggle."

"Well then, you must meet Valentin," this new friend insists, and I know immediately just who it is that he means. Valentin Santana is the historic leader, the iconic figurehead, and the most publicly recognized member of La Piedrita. After a few frenetic phone calls in which our proposed visit is repeatedly rebuked, our persistence pays off and we are cleared to head up to La Piedrita. We begin the climb upward, past Blocks 5, 6, and 7 of 23 de Enero, after which the multicolored superblock towers for which the area is famous give way to shorter blocks that are grouped tightly to form large, enclosed squares that are, from a military perspective, easier to defend. They knew we were coming, and yet they performed surprise, hostility and militant discipline. Here, gun pointed at my chest, I can't help but feel like a young Herbert Matthews in the Cuban Sierra Maestra (in fact, La Piedrita adjoins the Sierra Maestra sec-

tor of 23 de Enero). Matthews, so the story mistakenly goes, was duped by Cuban guerrilla commander Fidel Castro, who in 1957 allegedly marched a small number of troops in circles past the *New York Times* journalist to exaggerate the strength of his forces.

Although this description of events has since been discredited, Matthews' name became synonymous with journalistic naiveté. This lesson notwithstanding, the power of guerrilla theater has not waned, with revolutionary movements—from the Sandinistas to the Zapatistas and beyond—increasingly fighting their battles in the media and the reactionary forces arrayed against them doing the same. But as I sit here witnessing a similar display, it dawns on me that there is little disconnect between image and actuality, and managing appearances is the performative equivalent to managing reality.

Today, La Piedrita's autonomous status is best expressed by the large, hand-painted sign that greets all visitors: 'Here La Piedrita gives the orders and the government obeys.'

La Piedrita's show of force itself requires the same sort of autonomous local control that it seeks to perform: the image is the reality, and the reality is one of radical autonomy from the state. This autonomy is not limited to the revolutionary context of contemporary Venezuela; La Piedrita has been fighting for more than 25 years.

Like many of the collectives dotting the revolutionary landscape of western Caracas, La Piedrita emerged as a spontaneous community response to the scourge of narcotracking, as young revolutionaries—imbued with the history and ideology of struggles past—confronted both the drug trade and the violently corrupt state that facilitated it. The collective's beginnings were modest, with a single member (Santana himself) devoted to what he calls *trabajo de hormiga*, "ant work:" publishing a small community newsletter that interwove references to Che Guevara with recipes and birthday wishes. This same spirit of humility was reflected in their chosen name, which refers to a "pebble," little more than a mild nuisance.

But La Piedrita would soon be something more than a nuisance to *malandros* (delinquents) and police alike, stamping out the drug trade entirely and effectively forcing the police out of their community. Today, La Piedrita's autonomous status is best expressed by the large, hand-painted sign that greets all visitors: "Here La Piedrita gives the orders and the government obeys." This is no exaggeration: the Chávez government once sent a captain of the military reserves into the zone, who was immediately taken into custody by the collective. When the official protested, explaining that he was merely there to scope out a possible escape route for the president in the event of a repeat of the 2002 coup, the response from La Piedrita was unambiguous: the government does not tell us anything, it must ask.

As I await Santana's arrival for my interview, the air in this corner of 23 de Enero is thick with tension. After a pipe bomb exploded prematurely while being placed outside the offices of the radically anti-Chavista chamber of commerce, Fedecmaras, on Feb. 24, 2008, government forces determined that a militant who was accidentally killed called this area home. Although Fedecmaras is widely loathed among Chavistas for participating in the short-lived 2002 coup in which Chávez was briefly replaced with the organization's then-head Pedro Carmona Estanga, planting pipe bombs was beyond the pale. For the first time in years, ever since these local militias had reached a sort of détente with the central state, police entered the area, searching homes for suspects associated with the self-styled "Venceremos Guerrilla Front," whose name appeared on flyers found at the scene.

For many, including Valentin Santana and La Piedrita, this unwelcome incursion was an open attack on their tradition of local autonomy, and they responded by making that autonomy perfectly clear: on April 3, a multitude of local collectives including La Piedrita engaged in an "armed blockade" of 23 de Enero, appearing publicly in ski masks and armed to the teeth to shut down the community with burning tires and barricades as a sharp warning to the government. Chávez issued a stern rebuke on his television program *Aló Presidente*, insisting that "these people don't look like revolutionaries to me, they look like terrorists"; he even suggested that they had become infiltrated tools of the CIA.

I am struck by the soft-spokenness of Santana, a militant organizer who, with his light skin and army-green cap, looks more like an Irish Republican Army member than the bearded guerrillas more commonly associated with Latin America. Now, sitting on a crumbling wall across from us, Santana scoffs at the suggestion that La Piedrita might be even inadvertently serving the interests of the imperial enemy. Instead he catalogs the collective's achievements: after the drug trade and the violence associated with it were stamped out, they turned to eliminating even private drug abuse and alcoholism and now were poised to confront domestic violence. Alongside the elimination of such scourges, the collective had long promoted alternatives, including cultural and sporting activities aimed at reinvigorating a sense of revolutionary community among local youth. In this struggle on two fronts—against threats to the community and toward the regeneration of its cultural fabric—Santana has given more than most. In 2006, his own young son Diego was killed alongside Warner Lopez, another young member of La Piedrita (according to Santana, they were killed by members of another radical armed organization, Jos. Pinto's Tupamaro party).

Later that same month, we were invited to ride along with these revolutionary collectives as the extreme left of the Chavista bloc made its displeasure clear in a caravan throughout the entire barrio of Catia, within which 23 de Enero is but a small part, insisting that "we are not terrorists." Nevertheless, despite such militant pleas, tensions would only increase. In the year that followed, members of La Piedrita declared several opposition leaders "military targets," they attacked the opposition's television station Globovision and other such targets with tear gas as "punishment" for crimes past and present, and Santana even

publicly threatened the life of Marcel Granier, the head of the other major opposition television network, RCTV. In response, Chávez again declared them "terrorists" and issued an arrest warrant for Santana himself. Noting the difficulty of arresting members of such militant organizations (one previous effort to arrest Santana had failed), Chávez even insisted that he would "go get him myself " and made clear what was at stake, adding, with a feigned ignorance of the group's history, that, "We can't allow La Piedrita such-and-such to become a state of its own." As a result of such conflicts, it might not be surprising to find critiques of Chávez on the far left: after all, these revolutionary militants now confront a Venezuelan state that, with its bloated bureaucracy, sordid corruption, violent police, and chaotic prisons, looks much like the state that had been killing and torturing them for decades.

In preparation for the caravan of militias, a young woman wandered through the crowd, offering to paint revolutionary slogans on car windshields. When one angry militant insisted, only half-seriously, that she adorn his windshield with the phrase "Death to Chávez!" she gasped audibly.

To fully grasp the relationship between these most revolutionary organizations and Chávez's government, we must understand not only her astounded gasp but also the angry outburst that elicited it. In other words, we must attempt to grapple with the fact that the vast majority of such militants—those who deeply despise corruption, bureaucracy, and even the state itself and are more likely to associate that state with torture, murder, and "disappearance"—are still Chavistas, at least for the time being.

I probe this peculiar tension during my discussion with Valentin Santana, attempting to wrap my head around a central element of the political process underway in Venezuela as a whole, namely, the relationship between the radical autonomy from the state that such collectives maintain and the unification of revolutionary forces to take and exercise state power under Chávez's leadership. But such a fundamental tension cannot be explained away easily. I ask Santana, this figure deemed a "terrorist" by the president and who that same president would soon seek to have arrested, what he thinks of Chávez. It is dark and so I cannot be certain, but his face seems to wear a smirk that suggests he foresees my confusion at the counterintuitive position he is about to assume: "Chávez is our maximum leader," he insists.

And so I begin from a seeming paradox: despite La Piedrita's militant autonomy and rejection of the Venezuelan state, its members nevertheless pledge their loyalty, however temporarily and contingently, to the man currently sitting atop that state. As should be abundantly clear by this point, what matters more than anything else for this revolutionary collective and groups like it is not what happens in the gilded halls of official power. More important than *el presidente* is *el proceso*, the deepening radicalization and autonomy of the revolutionary movements that constitute the "base" of the Bolivarian Revolution. But this is not to say that all that rests atop this base is mere "superstructure," that the realm of official politics is completely inconsequential, that the state itself does not enjoy a degree of autonomy.

Rather, as La Piedrita's seemingly paradoxical fidelity to Chávez illustrates, there instead exists a complex and dynamic interplay and mutual determination between the two: movements and state, "the people" and Chávez. By beginning with a paradox, we enter into an interstitial space, one suffering the painful in-betweenness that is to be against (para) the grain of the present (doxa): between the great leader and no leader at all, between the state and its absence, between paranoid errors of right and left, with the paradox of paradoxes best expressed in graffiti daubed near El Valle in southern Caracas reading, "Long Live Chávez, Not the Government."

Paradoxes, however, are generally intellectual creations, with the definition of doxa reserved for the privileged few. Like so many apparent paradoxes, therefore, this one too unravels and is to some degree resolved, in practice, by the work of 27 million tugging hands that strip away its congealed synchrony, its frozen timelessness. My starting point, therefore, is not the one we most commonly associate with contemporary Venezuela. It is not the story of an evil and all-powerful, would-be dictator centralizing all power in his own hands, nor is it the tragic account of a well-meaning populist led astray by the inherent corruption of power. On the contrary, it is not the story of a Great Leader blazing a shining path and dragging the people, naive and pliant, in His turbulent wake. It is not, in other words, any of the many stories we hear about Hugo Chávez, but that is simply because it is not a story about Chávez at all.

Far too often, discussions of contemporary Venezuela revolve around the figure of the Venezuelan president. Whether from opponents on the conservative right or the anarchist left or supporters in between, the myopia is the same. This is not without reason: since Chávez's election in 1998 after his imprisonment for a failed 1992 coup attempt, Venezuela has become a radically different place, and the "Bolivarian Revolution" that he inaugurated (in name, at least) has seen power wrested from old elites and unprecedented social improvements and is poised to transform even the state itself. But although Chávez is indeed important—and I hope eventually to recover the complexity of his current relationship to revolutionary movements and collectives—my point must be a different one.

Because often it is only through the simplicity of inversion that we can arrive at a higher level of subtlety, of complexity, and of nuance, the practical resolution of this paradox comes in the insistence from the outset that the Bolivarian Revolution is not about Hugo Chávez.

Chávez was not the center, not the driving force, not the individual revolutionary genius on whom the process as a whole relied or in whom it found a quasi-divine inspiration. To paraphrase the great Trinidadian theorist and historian C. L. R. James: Chávez, like the Haitian revolutionary Toussaint L'Ouverture, "did not make the revolution. It was the revolution that made" Chávez. Or, as a Venezuelan organizer told me: "Chávez didn't create the movements, we created him."

MOVING_FORWARD

Following Chávez's death, a heated presidential campaign ensued between acting president Nicolás Maduro, a former bus driver who rose up the ranks to become Chávez's protégé, and opposition leader Henrique Capriles Radonski, the governor who lost to Chávez in the October 2012 presidential election.

The April 14 election delivered an unexpectedly narrow margin of victory for Maduro, with just 50.8 percent of the vote to Capriles' 49.1 percent.

Capriles refused to recognize the results, citing irregularities in the voting; deadly protests filled the streets of Caracas as Capriles called for demonstrations to demand a recount.

Venezuela's electoral authority, the National Electoral Council, has since declared the result "irreversible."

As Maduro serves out the rest of Chávez's six-year term, questions remain about how effectively he will lead a country suffering from inflation, food shortages and high crime without his predecessor's political acumen.

It also remains to be seen if Maduro will be able to hold together the "Chávismo" movement without its charismatic founder.

_ABOUT DREXEL

SCIENTIFIC_
AESTHETIC

The entrance portal of Drexel's Main Building, dedicated in 1891, is surmounted by a 19th-century emblematic nude figure representing the "Genius of Knowledge" with roundels containing the busts of the giants of the arts and sciences decorating the interior of the arch.

Founded in 1891 in Philadelphia, Drexel is a top-ranked, comprehensive university recognized for its focus on experiential learning through cooperative education, its commitment to cutting-edge academic technology and its growing enterprise of use-inspired research. With more than 24,500 students, Drexel is one of the nation's largest private universities.

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